NATURE

No. 4223 SATURDAY, OCTOBER 7, 1950 Vol. 166

CONTENTS

	Page
Town and Country Planning as a Social Service	573
Structure of the Universe. By F. Hoyle	574
Technology of Polymeric Materials. By Dr. D. F. Twiss	575
Chemistry, Ancient and Modern. By Dr. S. F. Mason	577
Heat Transference. By G. R. Noakes	577
High-Energy Particles and Machines for their Acceleration. By D. W. Fry	580
Finger Prints and Disease. By Supt. F. R. Cherrill	581
Forestry in Water Catchment Areas. By R. M. Protharo	584
Present Position of the Theory of Continental Drift. By Prof. Ronald Good	585
Obituaries:	
Prof. H. S. Reed. By Prof. F. C. Steward and Dr. J. Dufrenoy	586
Prof. W. J. Dilling. By Dr. R. W. Brookfield	587
Mr. C. W. Parsons. By Prof. C. M. Yonge, F.R.S.	587
News and Views	588
Chemistry of Muscular Contraction	591
Scientific Interests of Adults. By W. E. Flood	592
Photosynthesis and Respiration: a Reinterpretation of Recent Work with Radioactive Carbon. By Prof. F. C. Steward and Dr. J. F. Thompson	593
Cinematographic Recording of the Velocity of Arterial Blood-flow. By J. M. Potter and D. A. McDonald	596
Some Observations on Biological Noise. By Dr. P. Fatt and Dr. B. Katz	597
The London Conference on Optical Instruments. By Dr. E. H. Linfoot	599
Industry and the Universities in Great Britain	599
Letters to the Editors:	
An Absolute Method for Measuring the Activity of Radioactive Isotopes.—Dr. J. F. Keene	601
Thin-Target Yield of $O^{18}(p,\alpha)N^{15}$.—C. Milelkowsky and R. T. Pauli	602
Photo-oxidation of Water by Ceric Ions.—Prof. M. G. Evans, F.R.S., and Dr. N. Uri	602
Photochemical Conversion of Stilbene to Phenanthrene.—Charles O. Parker and Paul E. Spoerri	603
Ferric Soaps as Catalysts for Vinyl Polymerization.—Jyotirindra Nath Sen and Prof. Santi R. Palit	603
Removal of Girard Reagent 'T' from Biological Ketonic Fractions not easily Extracted by Organic Solvents.—C. L. Walters	604
Possible f-Shell Covalency in the Actinide Elements.—Dr. Leonard I. Katzin; Dr. E. Glueckauf and H. A. C. McKay	605
Mode of Action of Specific Solvents for Bituminous Coals.—Dr. I. G. C. Dryden	606
Use of a Magnetic Field in Detecting Corrosion Currents.—F. Blaha	607
An Unusual α-p Decay Track.—D. Lal and H. J. Taylor	607
Estimation of Heterogeneous Error Variances.—A. S. C. Ehrenberg	608
Changes in the Histology of the Honey-bee Ventriculus Associated with the Ingestion of Certain Insecticides.—Miss E. H. Salkeld	608
Functions of Haemoglobin in *Daphnia*.—Prof. H. Munro Fox, F.R.S., Barbara M. Gilchrist and Elizabeth A. Phear	609
Supersensitivity of Denervated Organs to Chemical Stimuli.—N. Emmelin and A. Muren	610
Deoxyribonucleic Acid Content of Ovarian Cells in *Artemia salina*.—Dr. L. Lison and Mrs. N. Fautrez-Firlefyn	610
Polymely in a Frog.—Dr. A. G. Hamilton	611
Suckling Antidiuresis in Rabbits.—B. A. Cross	612
Preservation of Fish by the use of Nitrite Ice.—Dr. J. M. Shewan	613
Availability of the Magnesium of Grass to the Ruminant.—R. J. Garner	614
Effect of Temperature on the Consolidation of Soils.—W. A. Lewis	614
Ultrasonic Soldering of Aluminium.—B. E. Noltingk and E. A. Neppiras	615
The Discovery of Magnesium.—Dr. J. Newton Friend	615

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements only should be addressed to:
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

All rights reserved. Registered as a Newspaper at the General Post Office

TOWN AND COUNTRY PLANNING AS A SOCIAL SERVICE

AT the recent meeting at Birmingham of the British Association considerable interest was taken in a tour of Birmingham and the Black Country, arranged more particularly for the members of Sections E (Geography), F (Economics) and G (Engineering), by the West Midland Regional Planning Group. By a combination of statistical analysis and shrewd observation, this voluntary and independent body, which was formed in 1941, has collected and presented in its successive surveys "English County" (dealing with Herefordshire), "Land Classification in the West Midland Region", and "Conurbation", a survey of Birmingham and the Black Country, some of the fundamental data on which future planning policy must be based. The tour may be regarded as a further effort to awaken and sustain in a section of the scientific community the public interest which is essential if town and country planning is to be effective.

Town and country planning has, in fact, to-day become, as a recent broadsheet (No. 316) from Political and Economic Planning points out, a major social service in which local and central government co-operate. This broadsheet, which is one of the series dealing with the implications for an active democracy of some of the services which affect the lives of people in their local communities, describes briefly the present Town and Country Planning Act of 1947; and it examines, not the administrative and technical problems which arise, but rather the more general questions of the nature of town and country planning, its meaning for the ordinary citizen and the way it fits into the British pattern of democracy. It shows that physical planning on the scale required is only possible with the understanding and support of those who are being planned for—the public—and that if it fails to hold popular support town planning will lose the only driving force capable of making it an effective social measure.

The broadsheet shows only too plainly that there are real doubts as to whether local authorities will use the wide powers which they have been given over the future development of their areas with the full support of the public, or whether they will use them effectively at all. The question is whether our democratic institutions will carry through the major reforms required without becoming less democratic in the process, and the broadsheet directs attention to some of the dangers which attend any concentration of power in the hands of fewer authorities, even for sound technical and administrative reasons.

In town and country planning, the powers entrusted to the local authorities are very wide, affecting, potentially at least, the whole of the physical environment of the individual. Moreover, planning is a process which shows its positive effects only over a comparatively long period. It does not impinge on the individual in the same way as the National Health Service does, and he has little direct motive or incentive to take an interest in it unless some private plan of his own is affected. When this happens,

the individual tends either to protest to the local planning authority or to appeal to the Minister. Planners are thus liable to find that their closest contacts with the public are with those members of it who have real or imagined cause for complaint. They tend in consequence to decide that the public is obstructive, and has to be circumvented in its own interest.

There are other factors which encourage both the central and local authorities to feel that the less the public knows about their planning schemes the less trouble they will have. The task of planning, in so far as it is not purely technical, is largely one of reconciling, or striking a workable balance between, a whole series of divergent interests, private and public, short-term and long-term. It may seem to the planner not only that the layman can have few constructive suggestions to offer in such a complicated process, but also that the need to consult the public may upset the nice balance of needs and counter-claims which he has achieved in his plan.

In spite, however, of the further danger of arousing public expectations which the slender resources for building and development in Britain, and the inevitably slow pace of progress, will deny fulfilment for a matter of decades, failure to bring the public to understand and approve the aims of such schemes would be a mistake. Town planning has already to contend with the often conflicting demands of powerful public and private interests, as well as with the pressure of social forces, such as population movement, which we have not yet learnt to control. Its own technical immaturity and lack of experience constitute further obstacles which could become a real danger if the gulf between planners and planned be allowed to develop. The broadsheet issued by Political and Economic Planning is not so much a warning to the planners as a challenge to every citizen of goodwill, and to all who have specialized knowledge in some of the fields concerned, to play their part in filling or bridging that gulf, and in securing not merely a sympathetic and helpful handling of points of difficulty by local planning authorities, but also a widespread public understanding of what is involved. A sustained interest must be promoted in the processes by which the changes are to be concerted, both at the local level and at the broader national level where the claims for land for the military and electricity authorities, for example, have to be reconciled with those for agriculture and national parks.

STRUCTURE OF THE UNIVERSE

The Structure of the Universe

An Introduction to Cosmology. By Dr. G. J. Whitrow. (Hutchinson's University Library, No. 29.) Pp. 171. (London: Hutchinson's University Library, 1949.) 7*s*. 6*d*. net.

DR. WHITROW is to be congratulated on this survey of the cosmologies of essentially the pre-1939 period. The remarkable achievements of Hubble and his colleagues are described in detail—distance measurements, the velocity-distance law, and the large-scale uniformity of the distribution of matter in space being fully and adequately treated. Then follow two chapters that deal with space-time and the theory of relativity. These are written in a fluent, expert style and should prove of great value to the lay reader. They provide an excellent introduction to the difficult problems of cosmology that are treated in the last part of the book.

In cosmology more significance is attached to a few observational results than in any other branch of science. At first the uniformity of space and the red-shifts of the spectra of the extra-galactic nebulæ formed almost the only evidence available to cosmologists, and it was perhaps natural that some men of science should have come to regard this as a somewhat flimsy basis for the support of such weighty matters. But, as Einstein himself has pointed out, it is difficult to gainsay the orthodox interpretation of the red-shifts without undermining the whole structure of physical science. Nevertheless, it is of the first importance that our store of observational knowledge on this subject should be extended to the maximum degree, and it is for this reason that such great efforts have been made by Hubble to obtain crucial information from nebular counts. The completion of this work is only now within sight. In the meantime, by good fortune, vital new information has accrued from developments in astrophysics. Most important are, first, that several methods of deriving the ages of the stars within our own galaxy all yield results close to 4,000 million years; and second, that the galaxies must have condensed from a more diffuse background. Both these new requirements have a serious impact on many of the older cosmological theories.

Dr. Whitrow discusses the age of our galaxy at length, and directs attention to the discrepancy between the four thousand million years given by astrophysics and the very short age of the universe—no more than two thousand million years—demanded by many systems of cosmology. Perhaps even greater weight might have been attached to this discrepancy, especially in the case of Milne's kinematical theory. Milne was able to avoid many of the difficulties of other cosmologies by means of his dual time-scale. But this no longer suffices to explain away the ages of the stars, which are now determined by a method that uses the physical time-scale. This gives four thousand million years, in agreement with methods that use the dynamical time-scale.

Although this review is not intended to be critical of Dr. Whitrow's book, there is one error that should be pointed out. In the final paragraph on p. 147, Milne's explanation of the origin of angular momentum is highly commended. This part of Milne's theory has always seemed to the reviewer to be open to the serious criticism that many satellites of the great planets show no evidence of a large spontaneous increase of angular momentum. Also, Dr. Whitrow is wrong in saying that apart from Milne's theory there is no explanation of the origin of the spins of the galaxies. For this follows without difficulty in any theory that regards the galaxies as condensations in a diffuse gaseous medium.

But for the rest, the book is eminently readable and is packed with a fund of interesting historical details. It cannot fail to be a great success with all who are interested in the fascinating problems of cosmology.

F. HOYLE

TECHNOLOGY OF POLYMERIC MATERIALS

Fundamentals of Synthetic Polymer Technology in its Chemical and Physical Aspects

By R. Houwink. (Elsevier's Polymer Series, No. 1.) Pp. xii+258. 28*s*.

Elastomers and Plastomers

Their Chemistry, Physics and Technology. Edited by R. Houwink. (Elsevier's Polymer Series, No. 3.) Vol. 1: General Theory. Pp. xiv+495. 52*s*. 6*d*. Vol. 2: Manufacture, Properties and Applications. Pp. xvi+515. 50*s*. 6*d*. Vol. 3: Testing and Analysis: Tabulation of Properties. Contributed by B. B. S. T. Boonstra, A. G. Epprecht, R. Houwink, J. H. Teeple, J. W. F. van't Wout. Pp. 174. 27*s*. 6*d*.

(New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1948–50.)

WHEN chemistry is receiving so much publicity concerning the misapplication of its discoveries, it is a pleasant contrast to turn to achievements by scientific workers, mainly chemists, which have led to notable contributions to the amenities of modern life.

Half a century ago, students of chemistry were impressed by the classical achievements in the synthesis of indigo, just as their predecessors had been inspired by accounts of the synthesis of alizarin and even of the production of artificial ultramarine. Just before the First World War, a new trend in synthetic chemistry was revealing itself in attempts to progress beyond the earlier observations on the more or less spontaneous polymerization of isoprene to the preparation of rubber-like products by the forced or controlled polymerization of butadiene hydrocarbons generally. In Germany, these researches led to the small-scale manufacture of a new synthetic rubber, which although deficient in the more lively qualities of natural rubber nevertheless yielded a serviceable ebonite on appropriate vulcanization.

Later, advances came more rapidly with discovery that the properties of the polymerized product could be improved by modifying the molecular structure of the monomeric butadiene (for example, by using chlorobutadiene or chloroprene instead of the simple butadiene), or by 'copolymerization' of the butadiene with a second unsaturated compound, or by effecting polymerization of the 'monomers' in emulsion or in solution. By these modifications of procedure, synthetic rubbers were obtained of such improved quality that they attained commercial importance. Moreover, the new technique enabled the synthetic chemist to enhance the qualities of the product in selected directions so that an assortment of 'rubbers' with specific advantages for an appropriate range of special uses became available. Thus arose the manufacture of such well-known new types of 'rubber' as neoprene, 'butyl rubber' and the bunas.

Concurrently with these advances there came rapid progress in the field of synthetic thermoplastic products. This term comprises two types of materials, namely, those made by chemical treatment of high-molecular products provided by Nature and those in which the macromolecules are formed by chemical processes from substances of low molecular weight. Typical examples of these two groups are cellulose nitrate, or celluloid, and the phenol-formaldehyde 'resins'. Both these developments have involved systematic and detailed investigations into the preparation of possible new materials for eventual transformation into desired elastomers and plastomers, elucidation of the molecular-structural features of these two groups of products, discovery of means whereby the physical and mechanical characteristics of either group may be modified as desired, and elaboration of methods for making the most effective use of the products whether for conversion into moulded articles, sheeted material, filaments or fibres.

It is the aim of No. 1 and No. 3 of the Elsevier's Polymer Series of publications to give a general description of the fundamental background of the chemical and physical factors in the preparation and use of polymeric materials for manufacturing purposes. In No. 1, "Fundamentals of Synthetic Polymer Technology", which is a revised edition of the book previously published with the title "Technology of Synthetic Polymers", Dr. R. Houwink has primarily in view the requirements of university students. The subject-matter includes the molecular and colloid chemistry of polymers, their more important mechanical and physical properties and methods of testing these, and their general processing, followed by an account of the manufacture and outstanding properties of industrial products of this type, whether obtained by chemical treatment of natural colloidal products or by synthesis from non-colloid raw materials. This book has the advantages of single authorship and of revision from the previous edition. The English is generally good, although occasionally a little awkward, and author and subject indexes are provided; the rendering of proper names is more accurate than in many books of this class. There is a notable freedom from misprints or errors; among the few to be encountered are the description of ethylene dichloride as dichloroethylene (p. 23), and the classification of 'Plioform' (p. 232) as a cyclized derivative of natural rubber of the same type as 'Vulcalock'. No mention is made, as such, of the class of product derivable from natural rubber by treatment with stannic chloride; but stannic chloride is erroneously indicated (p. 188) instead of sulphur chloride as the agent for the manufacture, from unsaturated fatty oils, of the rubber substitute known as white factis.

In No. 3 of the Series, "Elastomers and Plastomers: their Chemistry, Physics and Technology", the ground covered is similar; but the treatment is much fuller and is extended to include also some natural products such as natural resins and asphalts, so that No. 3 is made up of Vols. 1, 2 and 3 on "General Theory", "Manufacture, Properties and Applications" and "Testing and Analysis: Tabulation of Properties", respectively. The three volumes of No. 3 are edited by Dr. Houwink and contain altogether some twenty-five chapters contributed by thirty experts representative of Great Britain, France, Holland, Switzerland and the United States. One result of this diversity of authorship, which might have been obviated by thorough editing, is an inconsistency in terminology and also in spelling. Some overlapping in the matter of various chapters is scarcely surprising; but there are indications of some haste in the editing. According to the table of contents as given on the dust cover of each of the three constituent volumes, Vol. 1 should include a prefatory statement by Dr. Houwink, but this preface has been omitted without comment. However, it seems evident that it was intended to explain the aims of this publication on "Elastomers and Plastomers",

which provides a reference book for the technologist and research worker in this rapidly growing field of applied chemistry and physics.

In Vol. 1, C. Koningsberger (Holland) contributes a chapter on the organic chemistry of the various types of macromolecular compounds and their synthesis; a chapter follows, by H. Wechsler, W. P. Hohenstein and H. Mark (United States), dealing with the kinetics and mechanism of polymerization-(and copolymerization-) reactions and of 'polycondensations'. G. J. van Amerongen (Holland) then contributes four chapters discussing respectively: the molecular and colloidal constitution of high-polymers; the characteristic mechanical properties of these high-molecular colloids and the influence of temperature on elasticity; and the structure of elastomers and plastomers as revealed by methods based on X-ray patterns, birefringence, and the infra-red, ultra-violet and Raman spectra, which is followed by a theoretical consideration of their permeability behaviour to gases and liquids and of their thermal conductivity; and the swelling and solubility behaviour towards liquids, the characteristics of the solutions and their application to determination of the magnitude and distribution of molecular weight in such polymers. L. Hartshorn (Great Britain) provides a chapter on the electrical properties of plastics and elastics, and R. S. Colborne (Great Britain) one on the theory of action of plasticizers and on their use. In view of the sub-title "General Theory" it is rather unexpected to find the further inclusion of an opening statistical chapter to Vol. 1, by H. A. Frank (Holland), on the economics of the plastics industry with respect to production, and another chapter, by H. Gibello (France), on the mechanical operations involved in the manufacture of various types of finished product.

In Vol. 2 of No. 3 the various authors deal with the "Manufacture, Properties and Applications" of the separate groups of elastomers and plastomers. Dr. Houwink, with the assistance of C. P. A. Kappelmeier (also of Holland) on resins for varnishes and lacquers, deals with the prominent class of phenol-formaldehyde plastomers; A. van Royen (Holland) with ion exchangers based on synthetic resins; G. Widmer and K. Frey (Switzerland) with the urea and melamine resins; H. T. Neher (United States) with polymers derived from ethylene and ethylenic compounds, for example, the vinyl, allyl and acrylic polymers as well as polystyrene; V. E. Yarsley, H. Kitchen and W. J. Grant (Great Britain) with the esters (organic and inorganic) and ethers of cellulose, and the various rayon fibres, giving incidentally an account of the fundamental structure of cellulose itself and of methods of analysis for cellulose plastics; A. D. Whitehead and S. H. Pinner (Great Britain) with protein plastics; and C. Diamond (Great Britain) with synthetic fibres from proteins. Synthetic polyamides (for example, nylon), silicone polymers, alkyd resins and natural resins (and their derivatives) are handled respectively by L. F. Salisbury, J. R. Elliott, J. R. Patterson and I. C. Clare (all of the United States). Chemical derivatives of natural rubber, for example, cyclized, oxidized, chlorinated and hydrochlorinated products are described by T. R. Dawson, and synthetic rubbers by W. J. S. Naunton (both of Great Britain). A section on asphalts by R. N. Traxler (United States) ends this volume.

Vol. 3 of "Elastomers and Plastomers", sub-titled "Testing and Analysis: Tabulation of Properties", is in five chapters. A very short introductory chapter by Dr. Houwink is succeeded by one by J. H. Teeple (United States) reviewing methods for testing moulding qualities and various mechanical or physical properties of the shaped materials and the influence of external conditions on the test results; the amount of detail is rather uneven. A chapter then follows by A. G. Epprecht (Switzerland) on the chemical analysis of polymers covering tests for detecting various elements, phenols, methyl and ethyl alcohol, phthalic acid, nitrate groups (here described as nitro groups), glycerol and other likely combined constituents of plastic materials. A tentative scheme of systematic qualitative analysis for plastics generally is then given; but, in view of the fact that commercial plastics are not likely to be chemically pure, such a scheme would need to be followed with care and considerable critical judgment; a similar comment applies with respect to specific tests for various individual plastics based on flame tests, specific gravity, saponification number, etc. Indeed, some of the material of this chapter, especially the tabulation of the resistance of various polymers to a long list of chemical agents including aqueous solutions, appears to indicate some hurriedness of preparation which, indeed, would accord with the survival of the sentence (p. 73): "This test is used to determine which ester an acid, possibly present, may exist as". A chapter follows on the quantitative analysis of individual polymers such as the various cellulose esters and ethers, polyvinyl compounds, etc.; but again, uncritical compiling or inadequate editing is suggested by the intrusion of qualitative tests some of which have received consideration, quite appropriately, in an earlier section, while others, for example, chlorinated diphenyl and chlorinated naphthalene, might be considered out of place also for other reasons. Almost one third of Vol. 3 is devoted to tabulations of properties of elastomers, by B. B. S. T. Boonstra (Holland), and of plastomers, by J. W. F. van't Wout and R. Houwink (Holland). Collections of such data on mechanical and electrical properties, etc., are of limited value, particularly for colloidal materials.

In "Elastomers and Plastomers" it is probable that Vol. 1 on "General Theory" will appeal more strongly to research workers, whereas Vol. 2 on "Manufacture, Properties and Applications" will be more helpful generally to the technologist and manufacturer. The selection of writers has ensured authoritative accounts of the different subjects and a wide outlook; but inevitably it has provided much scope for editorial alignments, some opportunities for which have survived for attention in a second edition which, for Vols. 1 and 2 at least, is almost certain to be needed. The class of materials discussed in No. 3 is, as indicated by the title, elastomers and plastomers, but elsewhere in the volumes is described as plastics and elastomers, plastics and elastics (in No. 1), and even simply as plastics.

Some of the terms which appear in alternative forms at the preference of different contributors are: sulphur and sulfur; inflammable, flammable and flamable; ethyl cellulose and ethylcellulose; methyl alcohol and methanol; polythene, polyethylene and polyethene; alkyds, alkydals and glyptals; urea resins and carbamide moulding compounds; benzoyl peroxide and dibenzoyl peroxide; micelles, micells, micellie, micellæ and micelli; Novolacs, Novolaks and Novolacks; Koresin, Korosin and Korosine. Such inconsistencies are regrettable because valuable

and comprehensive publications such as these could help much towards standardization of terminology in a field where there is already some tendency to laxity, for example, in the indiscriminate use of the terms 'curing' and 'vulcanization' and in the omission of the prefix 'poly-' from the name of a monomer when speaking of the polymerized substance. The checking of chemical names in the individual chapters appears to have been carefully done; but attention may be directed to trimethylpropane (presumably for trimethylol propane) and hexamethylene (for hexamethylene tetramine) in Vol. 2 (pp. 476 and 37 respectively). Simple misprints, however, are not infrequent. Each of the three volumes of "Elastomers and Plastomers" is illustrated and has its own subject index; but there is no author index.

The importance of industrial plastics is so great and has increased, and is still increasing, so rapidly that the attempt in these books to co-ordinate the available information and to give a constructive review of world-wide research results and theories is praiseworthy and of great potential benefit and assistance to scientific and technical workers in this field and also to students. Furthermore, the record of problems encountered and systematically solved will provide a fascinating insight for many who have a general interest in the achievements of modern science.

D. F. Twiss

CHEMISTRY, ANCIENT AND MODERN

Crucibles

The Story of Chemistry from Ancient Alchemy to Nuclear Fission. By Bernard Jaffe. New edition, revised and enlarged. Pp. xiii + 480. (London: Hutchinson's Scientific and Technical Publications, 1949.) 18*s*. net.

WHEN "Crucibles" first appeared in 1930, it quickly achieved wide popularity, particularly in the United States. Bernard Jaffe, the author, received the Francis Bacon Award for the "Humanizing of Knowledge", and the book was reprinted several times. In the present edition, which is the third, the original text has been revised, and augmented by the addition of material describing recent advances in the study of the atomic nucleus. Apart from the final chapters on the development of nuclear studies, the original, biographical, mode of treatment has been preserved throughout. The story of chemistry is presented in terms of the work and discoveries of historically important chemists, enlivened by the background of their personal histories.

Mr. Jaffe's knowledge of the history of chemistry and of chemists is extensive, though one or two errors may be detected where he deals with borderline topics. The Watt engine, for example, is described (p. 410) as being the first successful steam engine; but the Newcomen engine was at work in the coal pits and tin mines some half a century before Watt brought out his patent. However, from a historian's point of view, the main defect of the book lies in its biographical method of treatment. We are presented with a succession of chemists rather than with the development of chemistry, and so the discoveries of the individual in some cases seem arbitrary and unrelated to the connected historical development of chemistry itself. In a sense, the development of science has always transcended the individual worker, and this becomes more evident, if not more true, the nearer we approach to the present day. Thus, in the final chapters of "Crucibles", Mr. Jaffe of necessity has placed less emphasis upon the biographical approach and treats the development of nuclear chemistry more as an organic whole, bound together by the logic of inference and experiment.

Biographies, however, provide much more detail of human interest than austere analytical works, and in this "Crucibles" excels, ranging over such topics as the usefulness of Dalton's colour-blindness and the content of Kekulé's dreams. It is a most readable work, for Mr. Jaffe has an eye for quaint detail and a style that is fast-moving, though sometimes rather sensational.

S. F. Mason

HEAT TRANSFERENCE

An Introduction to Heat Transfer

By M. Fishenden and Prof. O. A. Saunders. Pp. x+206. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 15*s*. net.

THIS concise account of the science and practice of heat transfer has been written to meet the needs of university students of engineering. When it is remembered that many of the simplest laboratory experiments on heat transfer involve some very difficult theory for even a partial explanation, it will be realized that the large-scale problems of engineering and industry are only tractable by the use of approximations of sufficient accuracy for the job in hand. This kind of work, above all, requires a firm grounding in fundamental physical principles, and the purpose of this book is to guide the reader in relating a large number of practical problems to these principles, as the first step towards their solution. The numerical examples worked out in the text form valuable illustrations of the general plan of campaign.

In the chapter on radiation, the black-body laws are adapted to practical cases, and tables of data for the emission and absorption of radiation by flames, furnace gases, ammonia and other gases are given. The straightforward work on steady-state conduction is followed by an interesting geometrical method of calculating the rate of rise of temperature at any point before the steady state is reached, and examples on this method are worked out. The dimensional treatment of both free and forced convection is fully explained; and, in the chapter on forced convection, there is a detailed study of banks and nests of pipes, with appropriate tables of figures. There are also chapters on friction in its relation to convection transfer, and on the transfer of heat from a condensing vapour and to a boiling liquid.

When Fishenden and Saunders's "Calculation of Heat Transmission" appeared in 1932, it was reviewed in these columns as an important book, by which the authors had placed workers in the field of heat very heavily in their debt. Students will surely feel the same about this present volume, which is excellent to read and is directed to their needs with distinguished skill and great experience. The development and growing importance of the subject during the past twenty years or so is evidenced by the range of titles and dates of the papers listed in the bibliographies at the ends of the several chapters.

G. R. Noakes

A Text-book on Crystal Physics

By Dr. W. A. Wooster. Reprinted, with corrections. Pp. xxii+295. (Cambridge: At the University Press, 1949.) 21*s*. net.

THIS book still remains the only British text-book entirely devoted to crystal physics. It can also claim the merit of being the first to be written with a clear understanding of the relationship between the physical properties of crystals and their atomic structure. This appears to advantage in the treatment of the relations between structure types and optical properties. Interest in the experimental work is particularly well conveyed by the author, who has been largely responsible for the excellent laboratory course of crystal physics in the University of Cambridge. He has incorporated the essential principles of Voigt's standard treatise and achieves considerable condensation of the essential mathematics by the use of tensor notation.

It is assumed from the outset that the university student to whom the book is addressed has mastered the elements of physics and crystallography, so that his knowledge of mathematics includes vectorial algebra and can be readily extended to co-ordinate geometry and Cartesian tensors. Even so, the brevity of the more difficult passages gives the impression that they are intended to supplement a course of lectures conscientiously attended. It is to be hoped that a new edition will seek a happier solution of how to present the necessary mathematical equipment. Further chapters on the magnetic properties of crystals, on ferro-electrics and the physical problems of crystal growth are topics which the author may also be tempted to include, if only on account of their possible application to industry.

F. A. BANNISTER

Fertility and Hatchability of Chicken and Turkey Eggs

Edited by Lewis W. Taylor. Pp. xi+423. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 40*s*. net.

IT is rather unusual for so many experts to take a hand in the production of a book of the kind under review. This should make it much more valuable. Dr. Taylor has been instrumental in securing the services of nine of America's leading experts in their own particular sphere.

At first glance the book gives one the impression that it is 'dry' and not easily understood; but, as one dips into its pages, each chapter becomes more fascinating and exceedingly helpful to those concerned with the problems dealt with. While admitting that there are certain pages in the book which are of a technical nature, a large amount of the material can be understood by the average layman. Nevertheless, it undoubtedly is a book for the teacher and student, and I should imagine that it will find a place on many library bookshelves.

It is difficult to refer to any particular chapter, because all are well written, and the matter equally well arranged. There is no doubt, however, that Chapter 6, "Physical Conditions in Incubation", is of great value to the practical man. The writer alludes to many important points in connexion with successful incubation, some of which are still doubted by operators.

The book is illustrated by a series of excellent photographs. It is well printed and the general make-up is very pleasing to the eye. There are many reference tables and a good index. The glossary puts a finish to a book which is likely to enjoy a good sale. It certainly should find a place in all agricultural colleges and farm institutes.

H. HOWES

Rinehart Mathematical Tables, Formulas and Curves

Compiled by Prof. Harold D. Larsen. Pp. viii+264. (London: Chapman and Hall, Ltd., 1949.) 15*s*. net.

THIS book, as its title suggests, contains much information not normally included in a book of mathematical tables, and, although there are volumes in existence in which tabular material is supplemented by lists of formulæ, the latter usually occupy a few pages at most, and do not form a main part of the work.

In this case, 160 pages of tables are provided, leaving a further hundred pages for the formulæ and curves. The selection of the contents (to quote the preface) is based on a survey specifically carried out in order to determine which tables and formulæ are most frequently needed for use in mathematics, engineering and physics. Part 1 contains the usual tables of logarithms, trigonometrical functions, exponential functions, etc., to five-figure accuracy, and also some statistical information, nowadays of increasing importance. It would be impossible in the space of a short review to list in detail the contents of Part 2, which are wide and varied. In particular, there are forty-three derivatives, 430 indefinite integrals and sixty-four definite integrals, fifty-two series, and about eighty diagrams of well-known mathematical curves.

The book is well bound, and the general arrangement and the quality of the reproduction are most commendable.

J. H. PEARCE

British Fishing-Boats and Coastal Craft

Part 1: Historical Survey. By E. W. White. Pp. 54 + 20 plates. (London: H.M. Stationery Office, 1950.) 2*s*. net.

THE first impression given by this catalogue is that it is just a paraphrase of the earlier work, "British Fishing and Coastal Craft", by the late Mr. G. S. Laird Clowes. This is unfortunate, for it conceals much useful new material which has been put into it. I feel that it could have been re-cast in such a way as to do more justice to both authors. This is only a very minor grumble. The catalogue is a most valuable work at a most reasonable price.

There are some small points which might be given more consideration in a future edition. First, I do not feel that enough attention has been paid to Captain H. Lovegrove's article in the *Mariner's Mirror*, which appears to give a clear picture of lute sterns on the Sussex coast in Elizabethan times. Secondly, William Daniell's prints show many illustrations of Scottish fishing boats on the west coast of Scotland in the early nineteenth century which could be consulted with advantage. Double-ended decked smacks, Norse-type open boats rigged as two-masted luggers, and large cutters are all in evidence. Finally, if it was necessary to cite the testimony of Julius Cæsar three times to prove the existence of early curraghs, use might have been made of the Massiliote "Periplus" to show that they were employed in the tin trade with Brittany five hundred years earlier.

T. C. LETHBRIDGE

Popular Fallacies

A Book of Common Errors, Explained and Corrected with Copious References to Authorities. By A. S. E. Ackermann. Fourth edition. Pp. xv+843. (London: Simpkin Marshall, Ltd., 1950.) 30*s*. net.

IT is almost exactly twenty-seven years since the third edition of this well-known work of reference was published, and in his preface the author states that eight hundred additional fallacies have been dealt with, an increase of some 60 per cent on the number included earlier. He adds, rather frighteningly, that he has still some 1,150 probable fallacies on his card index but "insufficient evidence by which to convict them". This statement gives a fair indication of the meticulous care with which Mr. Ackermann weighs the arguments before he demolishes any one of our cherished illusions.

The field covered by the book is very wide, and the reader will indeed be well informed if he cannot associate himself with Sir Richard Gregory's remark in the introduction that he has "derived both pleasure and profit from excursions into all its parts". He will need, too, to be made of sterner stuff than the reviewer if, after reading with some self-satisfaction an exposure of a fallacy to which he has long since ceased to subscribe, his eye is not caught by another, less familiar, and then another and so on until, before he realizes what has happened, the hours have flown and he has become a wiser man than when he started his perusal. A good book is furnished with a good index.

Modern Methods for the Analysis of Aluminium Alloys

By a Committee of Chemists convened by ALAR (the Association of Light Alloy Refiners). Editors: G. H. Osborn and W. Stross. Pp. vii+144. (London: Chapman and Hall, Ltd., 1949.) 13*s*. 6*d*. net.

THIS book is the outcome of the work of a committee of chemists of a group of firms specializing in the refining of secondary aluminium, and, in the belief that the results would be of wider interest, these have here been published. In addition to volumetric and gravimetric methods, photometric, electrolytic and polarographic processes, now firmly established, are well described. Spectroscopic methods, though widely employed, have been excluded on the ground that this field would require a book to itself. The important, but sometimes neglected, subject of the sampling of the material is given special attention. To all concerned with the analysis of aluminium alloys this book can be strongly recommended.

Proceedings of the Second Rubber Technology Conference held under the Auspices of the Institution of the Rubber Industry on June 23–25, 1948, at the Central Hall, Westminster, London, S.W.1

Edited by T. R. Dawson with the assistance of C. M. Blow and G. Gee. Pp. xxxii+523. (Cambridge: W. Heffer and Sons, Ltd., 1949.) 63*s*. net.

THE issue of the collected papers contributed to the 1948 Conference on Rubber Technology (reported in *Nature*, **162**, 204; 1948) provides a convenient reference book covering a wide range of topics connected with the science and technology of rubber. The papers are arranged under the following sectional headings: synthetic rubbers, chemistry of rubber, physics of rubber, testing and analysis, latices, compounding ingredients, factory processes and products. The intrinsic value of the papers is enhanced by the high quality of the printing and binding, and of the editorial work and general arrangement. Papers are followed by summaries of the discussions which took place at the meeting, and a report of the discussion on tensile strength, hardness, abrasion and tear testing is included.

L. R. G. TRELOAR

Modern Science and its Philosophy

By Philipp Frank. Pp. ix+324. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1949.) 36*s*. net.

THE author of this collection of essays is one of the original members of the group of thinkers afterwards known as the Vienna Circle, and he is here expounding its logical positivism or logical empiricism. The introductory chapter contains an interesting account of the development of the group and the derivation of its ideas from the work of Ernst Mach, Henri Poincaré, and a less-known French writer, Abel Rey. The exposition of Mach's philosophy in the early chapters is also worth having. Several chapters are controversial. Prof. P. Frank's way of dealing with points of view other than his own is to attach derogatory labels, such as 'Kantian' or 'idealist', and then dismiss them. This follows from his belief that there is only 'scientific truth' which is genuine (though purely phenomenal), and that all philosophies except his own consist of claims to some other kind of sham truth. In consequence, he is considerably embarrassed by the Marxists, who make the same claim for their own philosophy, and dismiss his by his own method as 'idealist'. The author's positive exposition of his own views is far from clear. He appears to think that pragmatists and Bridgman in his 'operational theory' are saying just about the same thing as phenomenalists.

A. D. R.

Introduction to Atomic Physics

By Prof. S. Tolansky. Third edition. Pp. xi+371+5 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 15*s*. net.

THIS new edition of Prof. Tolansky's book can be recommended with confidence. It contains a well-balanced account, suitable for second- and third-year students, of the fundamental aspects of atomic and nuclear physics and of many interesting applications of these subjects.

There are some minor criticisms one may offer. Occasionally too much detail is given, which tends to obscure the more basic aspects of an account. Sometimes, to go to the other extreme, oversimplification leads to some ambiguous statements and even errors. For example, the idea of stopping-power, discussed very briefly on pp. 242–243, gives the impression that the stopping-power of *any* sheet of material is proportional to the square root of the atomic weight; Prof. Tolansky means, of course, the atomic stopping-power. One section which might be re-written and brought up to date is that on pp. 235–237, on the detection of single α-particles. (It might also be extended to include the detection of other particles.)

However, despite these blemishes, this is much the best book published in Great Britain for introducing atomic and nuclear physics to science students.

J. D.

HIGH-ENERGY PARTICLES AND MACHINES FOR THEIR ACCELERATION

A GROUP of papers on high-energy particles and machines for their acceleration was arranged by Section A (Mathematics and Physics) of the British Association, and presented at Birmingham on August 31. In opening the session, Prof. R. E. Peierls said that our interest in fast particles arises from the fact that we wish to learn more about the nature of the forces occurring in the atomic nucleus. In the past fifty years, the fundamental laws governing atomic structure have been well established. The experimental data upon which they are based was obtained by a careful study of the interaction between electromagnetic waves of suitable wave-lengths, that is, light and X-rays and the internal electric fields of the atom. The refinements introduced by the quantum theory were necessary to take account of the small distances over which these electric fields are acting.

To establish the nature of the forces within the nucleus a similar study is necessary; but the important difference arises that these forces are known to be not electric in nature. They are much stronger than electric forces and act over shorter distances, the nucleus being of the order of 10^5 times smaller than the atom. To react strongly with these forces, bombarding projectiles of very high energies are necessary. For example, with more energetic particles than are yet available, we may hope to produce in the laboratory a meson heavier than the π-meson. There is some evidence for this particle in cosmic ray work. At about three times the highest energy yet achieved, negative protons may also be expected. They should occur in a similar way to the creation of positive and negative electrons by the interaction of electric fields. In addition, we must never overlook the possibility of new events occurring about which we know nothing at present.

Mr. D. W. Fry described recent progress with the travelling-wave linear accelerator method for producing high-energy electrons. The method employs the E_0-type electromagnetic wave, which may be built up in a cylindrical metal tube loaded with metal corrugations. The velocity of the wave and electrons injected into it may be made to remain in step as they travel along the accelerating tube. Radial defocusing fields may be overcome by applying a steady axial magnetic field. With an accelerator built at Malvern using a peak power of 2 MW. in 2-μsec. pulses on a wave-length of 10 cm., electrons were accelerated to 3·8 MeV. in a distance of 2 metres. The maximum accelerated pulse current was 300 m.amp. It is now being used at Harwell to generate a pulsed source of neutrons by the action of gamma-rays on beryllium. Neutrons of energies up to 1 keV. are available to study the properties of materials. A 15-MeV. accelerator to provide an even larger flux of high-energy neutrons is now being made. The main characteristics of a 10-MeV. machine being built for the Medical Research Council in Messrs. Metropolitan-Vickers Laboratories were also outlined. Mr. Fry said that the production of 1,000-MeV. electrons by a linear accelerator is now being considered. Theoretical studies by Mr. Harvie and his colleagues show that the power required to accelerate electrons to this energy might be reduced substantially by using wave-guides suitably loaded with low-loss high-permittivity ceramic disks instead of the copper diaphragms used so far. Experimental work upon these new types of wave-guide has been started.

Dr. L. U. Hibbard then described the University of Birmingham 1,000-MeV. proton synchrotron. It is a cyclic accelerator in which the particles travel around a toroidal-shaped vacuum chamber at an approximately constant radius. This chamber is placed between the poles of an A.C. magnet, acceleration taking place when the magnetic guiding field threading the annulus is increasing. A radio-frequency field is produced within the annulus by a C-shaped electrode, and the energy of the particles increases if they pass through this field at a suitable phase. Automatic synchronism between the particles and the radio-frequency field is maintained so long as the radio-frequency is suitably adjusted with increasing magnetic field. In the Birmingham machine the orbit radius is 450 cm. The magnetic field in the annulus rises to a maximum value of 15,000 gauss in one second. The radio-frequency accelerating voltage will be 240 volts r.m.s. produced between the ends of a C-shaped electrode stretching 130° around the annulus and an outer electrode at earth potential. Protons will be injected at 0·5 MeV. and the radio-frequency changed from 800 kc./s. to 30 Mc./s. during the acceleration of the particles. The magnet construction, excitation and cooling were described. To prevent an excessive loss of particles in the early stages by gas scattering, phase oscillations and other causes, the radio-frequency and the magnetic field must be accurately related. Also the working gas pressure must be not greater than 10^{-6} mm. of mercury. The steps being taken to meet these requirements were described.

Experiments using the 25-MeV. electron synchrotron at the Atomic Energy Research Establishment, Harwell, were discussed by Mr. F. K. Goward. Nuclear emulsions have been irradiated with the gamma-ray beam and the nuclear explosions producing three- and four-pronged stars examined. The three-pronged stars are found to be the disintegration products of carbon nuclei; the four-pronged ones are of oxygen nuclei. With carbon photodisintegration it is found that one alpha-particle is first emitted, leaving a beryllium-8 nucleus which then disintegrates into two alpha-particles. The beryllium-8 nucleus may be left in either the ground-state or an excited level. Goward and Wilkins have found that a large fraction of the observed events pass through the 3-MeV. level, but some pass through the ground-state. This latter condition had not been previously reported. The cross-section versus energy for the reaction has been measured; it shows a sharp fall above 18 MeV. This may be due to competitive processes, in particular the (γ, n) reaction. In the oxygen disintegration, it is found that the predominant mode of disintegration is via the 9·7-MeV. excited level of carbon-12 and not by initial splitting into two beryllium-8 atoms. The carbon-12 in turn splits into beryllium-8 nuclei, which then disintegrate into

two alpha-particles. Mr. Goward believes that the importance of these experiments lies in the information which they should provide for checking up the alpha-particle model of nuclear structure and the advances in nuclear techniques which are being made in these studies.

Experiments with the frequency-modulated cyclotron at Harwell were described by Dr. T. G. Pickavance. This machine, which first operated in December 1949, makes use of the principle of phase-stable particle orbits, described independently by Veksler and McMillan in 1945. It is designed to accelerate protons to a maximum energy of 175 MeV. The magnet poles are 110 in. in diameter and its power consumption 350 kW. for a central field of 16,000 gauss. The accelerated mean beam current is 1·5 microamp.

The first experiments carried out have been the measurement of total collision cross-section of high-energy neutrons in hydrogen. A well-collimated neutron beam, produced by the 171-MeV. proton beam falling on an internal beryllium target, was detected by counting recoil protons from a polythene disk in the beam with a triple-coincidence telescope of three proportional counters. Absorbers in the telescope limited the effective energy of the detectable neutrons to 156 MeV. The beam intensity was compared with and without attenuating rods of polythene and carbon in it. The measured total cross-section was $4{\cdot}64 \pm 0{\cdot}12 \times 10^{-26}$ cm.^{2}.

The energy spectra of neutrons ejected from beryllium, carbon and aluminium targets have also been measured and were shown. A triple-coincidence telescope was again used, the third counter being replaced with an ionization chamber gated to count protons over only a limited energy range. The energy spectrum was measured as a function of absorber thickness between counters for both polythene and carbon radiators. The transparency of beryllium, carbon and aluminium was found to decrease in that order; so also did the yield of high-energy neutrons.

Prof. P. M. S. Blackett concluded the session by describing evidence from cloud-chamber studies of cosmic ray showers for the existence of two new particles. In December 1947, Rochester and Butler published two cloud-chamber photographs containing forked tracks of a striking character. It was their opinion that one of the forked tracks represented the spontaneous transformation in the gas of the cloud chamber of a new type of uncharged particle into two lighter charged particles, and the other the transformation of a new type of charged particle into two light particles, one of which was charged and the other uncharged. The apparatus has since been taken to the top of the Pic du Midi, where the probability of finding further similar events should be increased by eighteen to twenty times. Six V-tracks have been found in the past two months. Prof. Blackett said he had also heard from Dr. C. Anderson of Pasadena that he has found thirty-four events having similar characteristics. Of Anderson's events, thirty may be interpreted as a neutral particle disintegrating into a positive and a negative particle, and four as a charged particle going to a lighter charged particle and a neutral one.

From preliminary analyses of the Pic du Midi photographs, it seems probable that the lighter particles are π-mesons, so that the disintegrations might be of the form:

$$V_0 \rightarrow \tau_+ + \tau_- \quad \text{or} \quad V_\pm \rightarrow \pi_\pm + \pi_0.$$

The energy of the new particle is in the region of 10^9 electron volts, and Butler's preliminary estimate of the mass of his π-mesons, 700–800, makes it rather lower than the present generally accepted figure. One photograph obtained might be open to interpretation as a double V-decay, but further evidence is required.

D. W. Fry

FINGER PRINTS AND DISEASE

By F. R. CHERRILL

Chief Superintendent-in-Charge, Finger Print Branch, Criminal Investigation Department, New Scotland Yard, London, S.W.1

As a result of examination of the hands of decomposed cadavers over a long period, it has been noticed that as a rule the muscles and skin of the left hand exhibit signs of greater decomposition than the right. This may be explained by the fact that the muscles, tendons, aponeuroses, etc., are less developed in the left hand than in the right, and would, therefore, less effectively withstand the ravages of the elements.

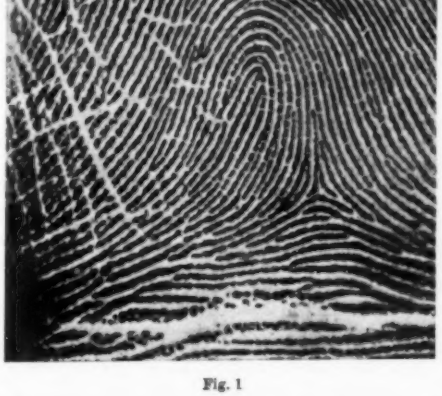


Fig. 1

Fig. 2

Fig. 3

Impression of left ring finger taken: top, on Nov. 8, 1946; bottom, on Nov. 12, 1948

Impression of left little finger taken: top, on Nov. 8, 1946; bottom, on Nov. 12, 1948

There may be other causes for the more rapid decomposition of the left hand; but it would need confirmation by the examination of the decomposed hands of left-handed persons and of the ambidextrous. Unfortunately, it is difficult to obtain reliable data for this purpose.

Since the left hand appears to be more susceptible to change under post-mortem conditions than the right, it was thought that the left hand of a living person might show certain signs indicative of disease, or even the approach of disease. A study of finger prints of persons suffering from certain pathological conditions lends some support to this contention.

A finger print is a picture of the papillary ridges on the distal phalanx of a finger or thumb which is obtained by inking the crests of the ridges. The immutability of the papillary ridges, which are formed early in fœtal life, is an established fact.

There are, however, other markings which are encountered on the fingers of some persons, and which are not so evident. They are creases which occur in the distal phalanges of the fingers, and cross the paths of the papillary ridges at more or less acute angles. When they are present they appear in finger prints as white lines (Fig. 1).

The white lines are similar in appearance to the scars left after the severing of the papillary ridges by a knife or any other sharp instrument (Fig. 2).

It should be emphasized that the creases under discussion are not of occupational origin but are distinct from wrinkling—the result of immersion, or cracking of the skin arising from contact with weak irritants, such as lime, soda, etc. Experience shows that the skin quickly recovers when such contacts cease; the 'white line' creases, however, though not immutable, are more persistent. It is suggested that there may be some as yet undefined pathological cause for the occurrence of the creases which give rise to the white lines.

When present in finger prints, white lines are ignored for purposes of comparison as they are not permanent features and are known to increase or decrease, both in size and numbers, over given periods. These lines are noticeable in finger prints of babies and sometimes are markedly present in the prints of aged persons; but they are indicative neither of youth nor of age, since they may also be found in prints of persons of all ages.

An examination of a large number of prints of apparently normal persons ranging from the ages of 16–75 years shows that approximately 11–12 per cent disclose these white lines. It has been found that if the white lines are absent in the middle, ring and little fingers of the left hand they are rarely present in the others. They are mostly confined to these three fingers and often to prints of the ring and little fingers only.

Fig. 4

Fig. 5

Whatever the pathogenesis of the white lines under discussion, their variable occurrence in certain pathological conditions and the degree of the lesion may be pathognomonic.

Attached impressions taken of the left ring and little fingers (Fig. 3) on November 8, 1946, of a girl suffering from Darier's disease are compared with those taken on November 12, 1948. During the two intervening years the condition of the skin had clinically deteriorated considerably. It will be observed that the number of white lines present in 1946 had appreciably increased in 1948. On both occasions approximately the same pressure was applied in obtaining the prints. In afflicted persons the 'white lines' appear to be more common on the ring and little fingers of the left hand than on the other digits. They are also more common over the areas supplied by the dorsal cutaneous branch of the ulnar nerve.

This is further illustrated by the finger prints of a medical man suffering from lesions caused by radium. Fig. 4 shows that 'white lines' are almost absent from the prints of the right hand, but are marked in those of the left ring and little fingers, especially on the ulnar side of the ring finger (Fig. 5). The skin of the left forefinger had suffered most damage. It may also be significant that the disruption of the papillary ridges shows some similarity to that noticed in the prints of lepers. White lines have also been observed in the prints of the left ring and left little fingers of epileptics.

That the development of 'white lines' is not due to a biological process, but may continue after death, becomes evident from a comparison of finger prints of a woman aged ninety years, which were taken on two occasions after death. Although white lines were absent from the prints taken on the first occasion, they were very manifest in those of the left ring and left little fingers taken two days later. None was present in any of the prints of the remaining fingers.

In a case of poliomyelitis, the condition of the patient, 17½ years old, precluded satisfactory prints of the left hand being taken; after several attempts, however, prints, limited in area, were obtained. It will be observed that a distinct white line appears in the impression of the ring finger (Fig. 6). Inspection showed that creases were not present in any appreciable degree on the other fingers. Another outstanding feature disclosed by the prints was the abnormal distension of the mouths of the ducts of the sweat glands. The corneous and Malpighian layers of the epidermis also appeared to have atrophied to such an extent that in some areas of the prints two fine ridges replaced a single ridge occurring in a normal print (Fig. 7). This may have been caused by the impingement of the double row of papillæ of the dermis, corresponding to, and located immediately below, a single epidermal ridge. Such a condition is known to appear in finger prints taken of the dermis after the epidermis has been removed. A test of the sweat deposit from the fingers of each hand, obtained through the medium of slides, showed that the epithelium debris was far greater in the case of the right hand than of the left. This is in perfect harmony with the fact that the left hand was affected to a greater extent than the right. The sodium chloride crystals in the sweat deposit were considerably decreased both in size and quantity.

Fig. 6

Fig. 7

The finger print test was also applied successfully in a case of congenital ectodermal dysplasia of the anhydrotic type, attributed to the protracted action of fluorine on the pregnant mother[1].

Observation of the prints of a person suffering from a tubercular spine showed that with the progress of the disease the papillary ridges had atrophied to knife-edge dimensions.

Further investigation will be needed before any definite conclusions can be arrived at, but it is suggested that a prolonged scientific analysis of finger prints would, in some cases, supply evidence of incipient disease and of its progress. Owing to the prejudice which still lingers against the taking of finger prints, no matter for what purpose, it is unfortunately not easy to obtain them from the subjects who may prove of interest.

I wish to express my sincere thanks to Dr. W. Howlett Kelleher, physician superintendent of the Western Hospital, Fulham, London, S.W.6, for his assistance and permission to obtain finger prints from a patient under his care, and to Dr. Isaac Jones and Dr. Leo Spira for their helpful advice and interest.

[1] *Acta Med. Scand.*, Stockholm,, **127**, 570 (1947).

FORESTRY IN WATER CATCHMENT AREAS*

THE necessity for protecting the raw water from pollution in a water-supply catchment area, even with the provision of adequate mechanical filtration, demands close supervision of human activities and land utilization. The report of an official committee appointed in recent years to inquire into this[1] recommended that, subject to the existence of adequate filtration and measures for the disposal of sewage, land in catchment areas should be put to the utmost agricultural use. This recommendation is understandable in view of the considerable acreage of land taken up by water-supply catchment areas and the way in which agricultural land in Great Britain at the present day is being lost to production. At the same time, the factors of the physical landscape—altitude, climate and soil—are often unfavourable for agriculture, and in these instances the committee recommended that the land should be afforested, bearing in mind the requirements of adjacent agriculture.

A recent survey of the progress of afforestation in twenty-eight of the larger water-supply catchment areas in Britain reveals a very dismal picture. In only one is 20 per cent of the area afforested, and thirteen have no land under forest. The factors producing this situation are not hard to find. In a minority of instances, industrial pollution, particularly of the atmosphere, prevents successful growth. The cost of planting and tending the forest, with little immediate return for capital outlay, makes afforestation economically difficult. But the most important retarding factor is the problem of ownership. Only seven of the twenty-eight authorities own the whole of their catchment area, a further five own more than 50 per cent and eight own 20 per cent or less of their land. This lack of ownership prevents the complete control of activities within the catchment area. The Corporation of Birmingham in its catchment area in the Elan Valley has to observe commoners' rights, allowing them to control the surface of the ground but not to break it. The freehold areas that have been afforested in the Elan Valley since 1916 have been a financial loss, caused to a large extent by the depreciation of money values during the period in which the timber has been growing.

Economic difficulties of planting are being overcome by agreements made between water undertakers and the Forestry Commission, the former leasing land for future planting. Where absence of ownership prevents afforestation, there is obvious scope for the Forestry Commission to exercise its right of acquisition in preference to some of the suggested acquisitions of good sheep-farming land which have been made in recent months.

With the progress of afforestation so retarded, it is obvious that it is not yet possible in Great Britain to determine the effect of tree-cover on run-off, flooding, erosion and silting. In any event there is a lamentable lack of accurate and scientific record of stream flow and run-off. In the Lake Vyrnwy catchment area, with 20 per cent afforestation, there is no positive evidence of tree-cover either increasing or decreasing the run-off.

The absence of interest in recording stream-flow and run-off is probably due to the generally 'average' climate conditions in Britain, particularly the relatively few instances of rainfall of high intensity. However, when this does occur—as it did over a wide area in south-east Scotland and north-east England on August 12, 1948—the damage caused can be very considerable and with total costs running into several millions of pounds. Such conditions would certainly not be aggravated, and are far more likely to be alleviated, by the presence of tree-cover. A favourable influence would doubtless be exercised on reservoir silting. This is a long-term process; but in eleven out of the twenty-eight authorities it will become serious in reducing reservoir capacity within the next hundred years. The capacity of Abbeystead reservoir of the Lancaster Corporation has been reduced from 185 million to 100 million gallons since its construction in 1872.

In many of the catchment areas of Britain, peat deposits in the upper parts play an important part in decreasing run-off and maintaining dry-weather

* Substance of a symposium in Section K* (Forestry) of the British Association, held at Birmingham on August 31. Papers were read by R. Mansell Prothero, D. Lloyd, A. T. A. Learmonth and A. E. Fordham.

flow by absorbing rainfall. It is necessary to remove peat before planting, and it would have to be considered, if this were done on a large scale, what effect it would have on increasing the run-off before the trees reached a stage of development when they might take over the function formerly fulfilled by the peat.

In catchment areas where there is a considerable area of land at more than 1,500 ft. and therefore possibly unsuitable for tree-planting, there might be an effective combination of forestry and sheep farming. The land above this altitude might be used as summer pasture, the sheep being brought down to lower altitudes in the winter through sheep-walks left in the forest, provided that convenient winter pasture could be found outside the catchment area. On the other hand, it has been suggested that flooding on the Rivers Usk and Severn in recent years has been accentuated by increased run-off from the hills due to hill-draining. The latter might be necessary for successful sheep-farming in reservoir catchment areas, and its effect in increasing run-off would work in opposition to forest planted to control it.

Apart from the general suitability of forest as a form of land use in water-supply catchment areas, there is a need for positive evidence to be collected of its influence on run-off and stream flow and therefore on flooding, erosion and silting. Until more forest has been planted and many years have been given to such experiments in order to provide the necessary long-term averages, it will only be possible to make generalized statements and to draw on results and data from other parts of the world, where often environmental conditions and factors at work are very different from those in Great Britain.

R. M. PROTHERO

[1] Report of the Gathering Grounds Sub-Committee of the Central Advisory Water Committee. Gathering Grounds; Public Access, Afforestation and Agriculture. (London: H.M. Stationery Office, 1948.)

PRESENT POSITION OF THE THEORY OF CONTINENTAL DRIFT

IF the size and lively interest of the audience is any measure in such matters, the joint discussion held on September 1 during the recent Birmingham meeting of the British Association between Sections C (Geology), D (Zoology), E (Geography) and K (Botany), on "The Present Position of the Theory of Continental Drift", was a very successful one.

The principal contributors numbered eight, namely, Dr. J. R. F. Joyce and Prof. J. H. F. Umbgrove on the palæogeographical side; Prof. R. D'O. Good and Dr. H. E. Hinton speaking for the botanists and zoologists respectively; Prof. H. Jeffreys and Prof. S. W. Wooldridge representing the geophysicists and geomorphologists; and Prof. W. T. Gordon and Dr. J. B. Simpson speaking for the palæontologists. Strict attention to time-keeping—that bugbear of conferences—allowed also many comments from among the body of the audience. It was disappointing that neither of the first two speakers was present in person; but their communications were read for them.

Joint discussions have become a familiar and valuable feature of British Association meetings, and their purpose should not be misunderstood. They are seldom the occasion for the announcement of profound scientific discoveries, but serve chiefly as short refresher courses by which men of science of various interests may keep abreast of developments in some of the problems which may not be their own more particular concern, while they give to those most closely associated with them the opportunity of taking stock, of estimating what changes of emphasis are desirable, and of incorporating new ideas. It is more especially with these latter points in mind that these few comments on the discussion have been prepared by one of the biologists who took part.

The present position of the theory of continental drift can, in outline in any event, be quickly stated. It is that while most biologists and palæontologists find in some form of land-surface displacement the best working hypothesis to explain the facts of plant and animal distribution, and therefore tend to favour theories of continental drift, the majority of geophysicists and geologists reject it, not only because of the lack of direct positive evidence, but also because they know of no force capable of producing the required movement. This difference of opinion, here expressed in the briefest of terms, seems quite clear-cut, and calls for some consideration.

To begin with, there are two possible misconceptions to be cleared away. The idea of continental drift first found full expression in Wegener's theory (1912), in which a very definite chronological sequence of events is postulated, and more modern workers have modified this in various respects. Those who believe in continental drift need not necessarily, therefore, subscribe to all the details of Wegener, and this is not always fully appreciated. Rather similarly with the word 'drift'. Ideas formerly rigid have now become more supple, and support for some theory of continental displacement must not be taken to assume belief in exactly the kind of drifting movement suggested by Wegener. That there is nothing merely casuistical about these points can be shown by comparing the position of the biologists and geophysicists a little more closely.

The position of the biologists is that they are called upon to explain, within the terms of modern evolutionary theory, a great series of facts which, in a single phrase, may be called the remarkable floristic and faunistic relationships between distant countries. They find it impossible to believe that these are due to normal or even abnormal dissemination across the intervening spaces, and they are therefore obliged to think that the now sundered lands either were once connected by subaerial surfaces which have disappeared, or were once nearer to one another than they are at present. The former involves some theory of land bridges; the latter some theory of continental displacement. This is not the place to consider the relative merits of these and it can only be said that few, if any, biogeographers prefer the former to the latter. Nearly all, therefore, favour some displacement theory *faute de mieux*. If other scientific workers can provide them with a more satisfactory solution of their problems, well and good; but meanwhile the facts remain and have to be accounted for. Some biologists go further than this, and, with other protagonists of displacement, believe that the facts of biogeography afford direct evidence that this has taken place.

The position of most geophysicists and their co-workers, on the other hand, is that physical evidences and data must carry conclusive weight, and that since according to these evidences there is neither indication nor even possibility of continental drift, the idea

cannot be sustained and the biologists must seek elsewhere for their solution.

It must be confessed that biologists sometimes find this attitude a little too rigid for their liking, and feel that there is some real difference between the evidence in the two cases. They feel that the facts of plant and animal geography have an objectivity and stability greater than those of some beliefs concerning the physical condition of the earth. They notice in the latter that the moduli concerned are on occasions modified, and they feel also some misgivings about the completeness of the present picture of conditions deep within the earth. On the other hand, no doubt, some geophysicists feel that since biologists are rarely expert mathematicians and physicists enough to appreciate these mysteries, their opinions are of limited value.

All this emerged clearly enough from the discussion, but there were also plenty of indications that the cleavage of opinion is really not so fundamental as may appear. On one side, the biologists made it plain that they are not committed to the minutiæ of Wegener's theory; on the other hand, the contribution of Prof. Umbgrove, for example, showed that while drift in the classic sense may be unacceptable, something in the nature of crystal buckling and contraction may result in comparable degrees of horizontal displacement. Similarly, the possibility that vertical rather than horizontal earth movement may be sufficient to bridge some conspicuous gaps, the discussion of the value of 'isthmian links' or stepping stones of island chains, and the suggestion that surer knowledge of the sequence of geological events might itself reduce the number of problems, were all feelers towards the integration which can with some confidence be looked for eventually of now opposing views.

There is space left to mention only a few of the many more particular points of interest raised. Perhaps the most original contribution was that of Dr. Joyce, who accepts the view that South Graham Land and its extension to King Edward VII Land is separated from the main mass of Antarctica by a trough. This smaller portion of Antarctica, together with the Scotia Arc of island groups east and south-east of Cape Horn, forms a loop, which when straightened out links up eastward with New Zealand, and forms a bond linking South America, Africa, Antarctica and Australia when these are placed in juxtaposition. The Scotia Arc so placed provides the missing fold region for the Antarctic.

Another nice point concerned the light relations in polar regions. In these highest latitudes, there are long continuous periods of daylight and of darkness, a condition presumably unaffected by secular temperature changes. Various fossil plants are known from the Antarctic continent, and the question is whether any of these could have existed under such light conditions as now prevail there. The implications of the answer have particular importance with regard to the Antarctic Tertiary flora.

Almost inevitably the likelihood of the population of isolated islands by casual methods of dispersal cropped up, and indeed in terms which suggested that the Kon-tiki epic was not the first of its kind; but there was evidently a feeling that to put too much weight on this is to burke the main issue.

An early speaker warned his audience against the uncritical use of reported cases of discontinuous distribution, and it was significant that the only instance of plant geography referred to afterwards was just such a case, that of *Cornus*, which has recently been quoted in connexion with continental drift[1]. The family of the Cornaceæ is one of the least satisfactory in Angiosperm classification and has suffered a series of dismemberments and revisions. Its chief genus, *Cornus*, contains several very distinct sections, some of which have been regarded as distinct genera, and the significance of any geographical statements based on its classification can only be regarded as most doubtful.

Discontinuity also received attention in the question as to whether the similarity between organisms in places far distant from one another might be due, not to community of origin but to parallel or convergent evolution, a possibility that must always be remembered.

Other questions were of a more severely practical sort, and these more than any others betokened what was perhaps the most noteworthy impression left by the discussion, namely, the need for more factual information about certain crucial issues. When, to quote but one such issue as an example, we really know of what the floors of the oceans are made, then we may speculate more happily as to how the material got there.

RONALD GOOD

[1] Longwell, C. R., *Amer. J. Sci.*, **242**, 218 (1944).

OBITUARIES

Prof. H. S. Reed

PROF. HOWARD SPRAGUE REED, widely known as a botanist, plant physiologist, and since 1935 a member of the faculty of the University of California, died at the age of seventy-three on May 12, 1950, in Berkeley, California. For many years Dr. Reed was associated with the Citrus Experiment Station at Riverside, California, and many visitors to that research station will recall his genial hospitality and keen interest in other people and other problems than his own. For the last fifteen years of his life, Dr. Reed resided at Berkeley, California, where he was associated with the Division of Plant Nutrition of the University of California.

To readers of the literature of plant physiology, Prof. Reed first became well known for his writings on growth and its analysis in mathematical terms. Later, his interests turned to cytochemistry, especially in the attempt to trace by its aid the role of the micro-nutrients in the growth of plants. Dr. Reed's wide scholarly interests, however, were given expression in his historical works, notably "A Short History of Plant Sciences", published in 1942, and still more recently an appreciation of the work of Ingen Housz in relation to the early history of photosynthesis.

Those, however, who were privileged to know the man, recall a serene and gentle personality and a mind which ranged far beyond the confines of his special field of work. Always keenly interested in the classics, he had an avid interest also in ancient history and ancient cultures, especially in the Aztec language and culture. On his extensive travels, Prof. Reed was indefatigable in pursuing his interests in plant physiology, while also adding to his store of knowledge of both present and past customs and cultures. These wide interests and experiences made him a delightful host and a welcome guest. No account of Prof. Reed should, however, omit reference to his broad and deep interests in human affairs

and human welfare. In individuals, whether students, colleagues or visiting men of science, he found a ready interest; his church claimed his loyalty and service, and to the American Association for the Advancement of Science he gave his counsel as one of its national officers for some years.

Prof. Reed leaves his mark indelibly on the literature of botany and plant physiology: he will long be remembered with affection by a wide circle of colleagues, students and friends in many lands.

F. C. Steward
J. Dufrenoy

Prof. W. J. Dilling

Prof. Walter James Dilling, who had held the chair of pharmacology at the University of Liverpool since 1930, died at Coniston on August 18 at the age of sixty-four.

Educated at Robert Gordon's College and the University of Aberdeen, he graduated M.B., Ch.B. with honours in 1907. He became second assistant to Prof. J. A. MacWilliam in the Department of Physiology and was afterwards appointed Carnegie research scholar in physiology. In 1909, as Carnegie research fellow in pharmacology, he studied in Germany and was for a time first assistant to Rudolf Kobert, professor of pharmacology and physiological chemistry at the University of Rostock. He returned to Aberdeen in 1910 to become lecturer in pharmacology, where he conducted a course in experimental pharmacology for medical students, which was the first of its kind in Great Britain. In 1914 he was appointed to the new Robert Pollok lectureship in materia medica and pharmacology in the University of Glasgow. His work there was interrupted by war service, and in 1915 he was commissioned in the R.A.M.C., with which he served until 1919. After a further period in Glasgow he went as lecturer in pharmacology to Liverpool in 1920. His merits as teacher and administrator soon gained recognition; he received the title of associate professor in 1926 and in 1930 was appointed to the newly created chair of pharmacology.

Prof. Dilling was deservedly popular with his students. His carefully prepared and constantly revised lectures were full of vitality and were embellished by humorous sallies which delighted his hearers. He was dean of the Faculty of Medicine during 1924–35 and again during 1939–45. His wise tolerance and able administration earned him the gratitude of colleagues and students alike. He was twice a member of the University Council. He was at various times an examiner to the Universities of Oxford, Cambridge, London, St. Andrews, Bristol, Leeds, Sheffield, Birmingham and Wales.

In 1938 he was nominated to the General Medical Council, and in 1948 became chairman of its Pharmacopœia Committee. He was a Privy Council representative on the Council of the Pharmaceutical Society and served as a member of the Pharmacology Committee for the British Pharmacopœia, 1948.

Prof. Dilling was the author of many papers on physiological and pharmacological subjects. Early researches led to the publication of an "Atlas of Crystals and Spectra of the Hæmochromogens" in 1910. Other studies included investigations into the pharmacological actions of certain unfamiliar plants, of quinine on the parturient uterus and of lead compounds. He also wrote on medical historical subjects. But it was as a writer of text-books that he excelled. Very early in his career he edited Bruce's "Textbook of Materia Medica", which became widely known to generations of students as "Bruce and Dilling". Frequent revisions were undertaken with characteristic energy and thoroughness, and were remarkable not only for their clear presentation of the most recent developments in pharmacology, but also for their understanding of the clinical problems attending the application of drugs, new and old. Under the revised title of "The Pharmacology and Therapeutics of the Materia Medica", the book had reached its eighteenth edition in 1944 and revision for the nineteenth edition was almost complete at the time of his death. From 1940 onwards he contributed the important chapter on recent developments in drug therapy to the annual "Medical Progress" volume of the "British Encyclopædia of Medical Practice". He had a profound knowledge of his subject as applied to both veterinary and dental practice. He was joint author, with S. Hallam, of another widely used text-book, "Dental Materia Medica, Pharmacology and Therapeutics", now in its third edition.

His interests were wide and embraced many subjects besides pharmacology. He had a life-long love of music and was chairman of the Liverpool Philharmonic Society for several years. At his home in Coniston he was a countryman, keenly interested in rural ways and Lakeland life, of which he acquired an extensive knowledge. To a keen and critical intellect he joined the utmost friendliness, and those who approached him for advice or help found him ready to give freely of his time and energies to the solution of their problems. During the Second World War he commanded the medical company of the University Senior Training Corps and spent long hours with his student stretcher bearers receiving casualties at the railway terminus, sometimes far into the night. These and other war-time activities took heavy toll of his energies and eventually of his health, and he never fully recovered from the prolonged strain which a high sense of duty imposed upon him. His loss is mourned by a wide circle of friends. He leaves a widow and two daughters.

R. W. Brookfield

Mr. C. W. Parsons

Charles Wynford Parsons was born in 1901 at Swansea, the son of Tom Posslethwaite Parsons. He was educated at Bristol Grammar School, proceeded to St. John's College, Cambridge, in 1920, and, after graduation in 1924, was appointed assistant in the Department of Zoology, University of Glasgow. There he remained, attaining the position of senior lecturer, until his untimely death at Birmingham on August 26.

Parsons's first published work was on the behaviour of *Amœba*; but his interests soon changed, as was but natural in a department then under the direction of Graham Kerr and noted for its contributions to vertebrate morphology and embryology. After a valuable paper on the conus arteriosus in fishes, he received for examination the penguin embryos collected during the *Discovery* investigations, and his beautifully illustrated report on these, published in "Discovery Reports" in 1932, represents his major contribution to zoological knowledge. It was followed two years later by an account of similar material collected during the course of the British Antarctic (*Terra Nova*) Expedition of 1910. This included

embryos of the emperor penguin collected by Wilson, Bowers and Cherry-Garrard in the course of a terrible five-week journey in the antarctic winter of 1911. It was always a matter of pride to Charles Parsons that he was able, after a long series of misadventures at other hands, to publish the results of their labours.

But his interests were far wider than research. From the day of his arrival in Glasgow, Parsons threw himself wholeheartedly into the work of the Department and into the life of the University. He was keenly interested in what was then the O.T.C. and rose to the rank of major in command of the Artillery Unit. He served on the Faculties of Science and Medicine, was for some time a member of Senate and sat on many University committees. On three occasions he took charge for lengthy periods of the Department. He took great pride in the Hunterian Museum of Zoology, which he represented on the Scottish branch of the Museums Association. He was elected a fellow of the Royal Society of Edinburgh in 1933 and served on its Council. He was a vice-president of the Royal Philosophical Society of Glasgow and was a member of the Executive Committee, later Council, of the Scottish Marine Biological Association, acting as chairman for several periods. The marine laboratory at Millport owes much to him.

By his colleagues in the Department of Zoology at Glasgow and in the University generally, as well as by innumerable students, he will long be remembered as a most lovable man. He was an admirable teacher, always fresh and stimulating and keenly interested in his students. He served under three professors of zoology, all of whom survive him—Sir John Graham Kerr, Dr. Edward Hindle and the writer. Each had the benefit of his completely unselfish devotion to the Department, and all unite in their appreciation of him as friend and colleague. He was most happily married, and the profound sympathy of many friends goes out to Mrs. Parsons and to their four children.

C. M. YONGE

NEWS and VIEWS

University of Birmingham

SIR RAYMOND PRIESTLEY, whose tenure of office of vice-chancellor of the University of Birmingham would normally end this year, has been asked to continue in office for a further period and has expressed his willingness to do so. This decision will give much pleasure to students and staff, for they have a warm regard for Sir Raymond. It will also give the vice-chancellor an opportunity of realizing at least part of the object for which he was appointed, namely, that of the bringing together of all the departments of the University on to the Edgbaston site and so ending the present fission.

A notable development in the coming session is the establishment of postgraduate courses in mechanical engineering, chemical engineering and metallurgy. Arrangements are being made for thirty-six postgraduate students to be selected by the University from candidates who are graduates or have equivalent qualifications and who have spent some years in industry. These will be assisted with grants of £220–£400 from the University Grants Committee. For the accommodation of these postgraduate students a large house in Edgbaston has been acquired as a hostel which can hold up to forty men. The success of the scheme requires the co-operation of industrialists who may have to make some sacrifice to enable some of their key men to avail themselves of this opportunity, but it is believed that the consequent benefits will well repay the sacrifice. A considerable part of the new buildings of the Mechanical Engineering Department is already in use, and more will be available in the ensuing session. Much of the equipment has been the gift of large firms who have shown sympathetic appreciation of the nature of closer contact between the University and industry.

Economy of Greenland

MUCH useful information about Greenland and valuable statistical tables relating to that country's demography, climatic conditions, trade, fishing industry and social life is contained in a work entitled "Economic Principles of the Greenland Administration before 1947" (pp. 215; København: C. A. Reitzels Forlag, 1949; 18.50 kr.). The author, Mr. P. P. Sveistrup, is well qualified to write on the subject, as he has spent nineteen years in the administration of Greenland. In recent years, Greenland's foreign trade has been largely concerned with the export of salted cod, the cod fisheries now having replaced sealing as the main economic activity. The decline in sealing has been caused by hunting in the breeding grounds and possibly also by a change in climate, as there appears to be a close connexion between the quantities of pack-ice (which carries the seals with it) and the catch of seals. This change has meant that Greenlanders have now to rely on imports from the outside world to a greater extent than formerly when the seals, through their various joint products—meat, blubber and skins—furnished most of the necessities for living. The only mineral at present being worked is cryolite, which is of considerable economic importance. The author devotes much of his space to the price policy that has been followed, and that which ought to be followed, by the administration. He points out that Greenland's economic structure is such that export prices fluctuate far more violently than import prices, and he concludes that, since imports are necessary for existence, a trade monopoly which stabilizes prices and thus isolates the Greenlanders from the trade cycle is desirable. To the economist, the sociologist and the geographer, Greenland is of especial interest in that, owing to its climate, it is very near the limit of minimal existence. It is therefore to be regretted that the translation of this book from the Danish into English has not been well done and that much patience is required to unravel what is meant by many of the paragraphs.

The Census of England and Wales for 1931

THE Registrar-General for England and Wales has recently published the "General Report on the Census of England and Wales, 1931" (London: H.M. Stationery Office; 10s. net). This is the final publication of the Census of 1931. It was largely completed in 1936, but final completion was delayed by the necessity of concentrating on the supplementary county volumes, the last of which appeared in 1940. Shortage of staff and pressure of war-time work made publication during the War an impossibility. As a result of the long delay, most of the

material in the general report is now only of historical interest, as conditions have changed radically since 1931. The report contains an account of the machinery of the Census, together with a discussion of some of the more important general results and an account of some minor inquiries, such as the number of Welsh-speaking persons in Wales, and the distribution of the alien population. Most of the figures in this volume have already appeared in previous Census publications, but the staff of the General Register Office have performed the task of summarizing and condensing the information with their usual lucidity.

Metabolism of Humming-birds

By measuring oxygen consumption, Oliver P. Pearson has calculated the rate of metabolism of humming-birds at rest and in flight and their energy needs over a 24-hour period (*Condor*, **52**, No. 4; July–August 1950). Five anna (*Calypte anna*) and two allen (*Selasphorus sasin sasin*) humming-birds were studied and, resting in day-time, their rate of oxygen consumption was found to be higher than that of any other animal measured under comparable conditions. This high rate is in part balanced in both species by a period of torpidity at night, during which body temperature falls and oxygen consumption decreases to a significantly low rate. In captivity recovery from torpidity occurred spontaneously before daybreak; a peculiar feature was that torpidity did not occur in young anna humming-birds. Pearson also investigated the non-stop flight range of humming birds and showed that the maximum flight-range of the ruby-throated humming-bird, a migratory species suspected of making long over-water flights, is 385 miles.

India Section of the Electrochemical Society

The Electrochemical Society, Inc. (235 West 102nd Street, New York 25), is an organisation in the United States which was founded in 1902 to promote the advancement of electrochemistry, electrometallurgy, electrothermics, electronics and allied subjects. A section for India of this Society has been recently organised with headquarters at Bangalore, this being the first Section to be formed outside the United States. The officers of the Section are: *Chairman*, Dr. B. K. Ram Prasad, special officer, Electric Grid Offices, Government of Bombay, Bombay; *Vice-Chairman*, Dr. K. L. Ramaswamy, deputy production superintendent, Government of India Fertiliser Factory, Sindhri, and Mr. J. Balachandra, lecturer in electrometallurgy, Indian Institute of Science, Bangalore; *Secretary-Treasurer*, Dr. T. L. Rama Char, lecturer in electrochemistry, Indian Institute of Science, Bangalore. The inaugural meeting of the Section was held during March 23–24 at the Indian Institute of Science, Bangalore, and was well attended by scientific workers, engineers, industrialists and others interested in the future of electrochemistry in India. Dr. B. K. Ram Prasad delivered the inaugural address and spoke on "Some Aspects of the Development of Electrochemical Industries in India". He indicated that there are great possibilities for the development of these industries, keeping in view the availability of raw materials, present output of electric power and future power development plans. Dr. Prasad said that he felt glad that the Government of India had decided to establish an Electro-Chemical Research Institute at Karaikudi, and expressed the hope that the Planning Commission recently set up by the Government would consider in detail the development of electrochemical industries in India.

Electronics for Spectroscopists

The second annual summer school on electronics for spectroscopists, sponsored by the Photoelectric Spectrometry Group, which was held during July 8–15, was again organised at University College, Southampton. Mr. C. G. Cannon was organising secretary on behalf of the Group. The syllabus of the course placed emphasis on electronic techniques used in all aspects of spectroscopy. Lectures and demonstrations given by Prof. E. E. Zepler, S. W. Punnett, T. B. Tomlinson and G. H. Johns (Department of Electronics), included amplifier theory, effects of feedback, design of selective amplifiers, D.C. amplifiers, sources of noise and the calculation of noise in circuits, stabilized power supplies, and general consideration of circuit design, testing and fault finding. Prof. A. M. Taylor gave a discourse on the "Optics of Spectrometers", which included illumination of entrance slit-collimator systems; errors to finite slit-widths, and the choice of slit-width; polarization by spectrographs; and problems of 'lining up' and focusing. Two invited speakers contributed lectures on specialized subjects: Dr. A. Elliott (Courtaulds, Ltd., Maidenhead) spoke on the theory, use and experimental techniques of polarized infra-red radiation; and Dr. E. F. Daly (Unicam Instruments, Cambridge) lectured on the theory, mechanics and electronics of fast scanning of spectra, and on double-beam fast scanning with cathode ray tube presentation. There were three visitors from overseas: Dr. E. Kuyper (Royal Dutch Shell, Amsterdam); Mr. F. Woutman (C.I.M., Delft); and Dr. M. Sanz (Dr. A. Wander S.A., Berne).

Polish Academy of Science and Letters

The nineteenth annual publication of the Nature Protection Committee of the Polish Academy of Science and Letters contains English summaries of all articles. Among these is one by Jan Zabiński describing the work done in Poland since 1945 to save the European bison from extinction. The work has been initiated by the Bureau of Nature Protection, which, besides setting aside reserves in Poland, each year assigns a certain number of animals for exchange with other countries interested in the problem of bison protection. Through Polish activity in the last four years two breeding centres have been established in the U.S.S.R. and one in Denmark; it is hoped that breeding centres will also be developed in Belgium, Switzerland and, perhaps, Czechoslovakia. Other articles include one by Aleksander Kosiba on problems of Nature protection in the Arctic; Jan Walas on the edelweiss; Jan Boguslaw Szczepski on the biology of the mallard; and Roman J. Wojtusiak on extinct and vanishing mammals.

International Collection of Cytological Preparations

An International Collection of Cytological Preparations, under the auspices of the International Union of Biological Sciences, is housed in the Carnoy Institute at Louvain, Belgium. The Collection is in the charge of Prof. P. Martens, director of the Institute. Cytologists of all countries are invited to deposit in the Collection some of the slides which have served as the basis of their published researches. More than 8,000 preparations have already been assembled.

Biologists are thus given the opportunity, by visiting the Collection, of comparing their own work with that of others. The preparations deposited remain the property of the depositors, who may at any time reclaim them.

Science Reports of Tohoku University, Japan

REPORTS from the Research Institute for Iron, Steel and Other Metals of Tohoku University, Sendai, Japan, used to regularly appear in a Tohoku University publication called *Science Reports*. Since 1944 and the issue of Vol. 32, this publication has been suspended. The Association of Research Institutes of Tohoku University has recently commenced the issue of a new set of *Science Reports*. This is divided into three sections, Series A, B and C, of which the first is devoted to physics, chemistry and metallurgy. The scientific and technological reports of the Research Institute for Iron, Steel and Other Metals will be printed in Series A. The first two numbers of Vol. 1, Series A, were published in May and August 1949.

Earthquake Records at De Bilt, Netherlands

DR. F. A. VENING MEINESZ, director-in-chief of the Royal Netherlands Meteorological Institute, states that, owing to war circumstances, the seismological station at De Bilt was not recording earthquakes during October 11, 1944–June 1, 1945. Fortunately, neither the instruments nor the building were damaged, and recording began again when electric power was available on June 1, 1945. The seismological bulletin issued for the period June 1–December 31, 1945 (Seismic Records at De Bilt, 33, 1945. Pp. vii+16. ('s-Gravenhage: Koninklijk Nederlands Meteorologisch Instituut, 1949.) 1 f.), shows 189 recorded earthquakes which could be interpreted and timed. The records have been reduced by Dr. J. Veldkamp, director of the Section for Terrestrial Magnetism and Seismology, and by Mr. J. Oldeman, scientific assistant. The instruments in action during the period were three Galitzin seismographs, one astatic Wiechert horizontal seismograph and two Bosch horizontal pendulums. The last three were, in general, interpreted only when necessary to supplement the Galitzin readings.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: Dr. E. M. Chenery (soil chemist, Agricultural Department, Trinidad), chemist, Agricultural Department, Uganda; C. W. L. Fishlock (director of agriculture, British Honduras), senior agricultural officer, Tanganyika; G. M. Roddan (deputy director of agriculture, Kenya), director of agriculture, Nyasaland; R. R. Waterer (conservator of forests, Cyprus), conservator of forests, Kenya; G. B. Smart (medical officer, Hong Kong), pathologist, Hong Kong; V. R. S. Beckley and W. R. Birch, agricultural officers, Kenya; A. E. Carlaw and M. J. W. English, agricultural officers, Tanganyika; J. M. B. Harley, research officer (entomologist), East Africa High Commission; E. W. King, agricultural officer, Uganda; H. H. Roberts, agricultural officer, Northern Rhodesia; E. T. Wilnot, agricultural officer, Nyasaland; D. N. Holt, geologist, Nyasaland; L. D. Sanders, geologist, Kenya; Dr. S. G. Cowper, pathologist, Mauritius; J. H. Caley, staff surveyor, Forest Department, Kenya; R. S. Pinniget, veterinary officer, Tanganyika; D. P. Franklin, agricultural superintendent, Nigeria; D. V. Mackenzie, assistant meteorologist, Nigeria.

Announcements

THE new building of the Imperial Forestry Institute, Oxford, will be opened by H.R.H. Princess Margaret on October 19.

THE Council of the British Welding Research Association has awarded the Welding Research Prize for 1949 to Dr. K. Winterton, Mr. J. G. Ball and Mr. C. L. M. Cottrell for their joint paper entitled "A New Weldability Test for Magnesium Alloy Sheet". This Prize (£100) has been given by the British Oxygen Co., Ltd., which has offered to provide a prize fund for three years for a competition relating to welding. The closing date for entries for the 1950 competition has been extended to December 31, 1950. Further information can be obtained from the Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

MR. PAUL ADORIAN, assistant managing director of Broadcast Relay Services, Ltd., has been elected president of the British Institution of Radio Engineers. Mr. Adorian, who was a student at the City and Guilds Engineering College, joined the Rediffusion group of companies in 1932 as a development engineer and was appointed chief engineer in 1936. His main technical work has been on the development of relay systems and industrial electronics, and he has been directly associated with work on synthetic training methods for airmen.

APPOINTMENTS to the [Australian] National Standards Commission have been announced as follows: *Chairman*, Prof. L. G. H. Huxley (professor of physics, University of Adelaide); *Members*, Dr. G. H. Briggs (chief, Division of Physics, Commonwealth Scientific and Industrial Research Organisation), Mr. N. A. Esserman (chief, Division of Metrology, C.S.I.R.O.), Mr. W. M. Holmes (formerly superintendent of weights and measures, Victoria) and Mr. F. J. Lehany (chief, Division of Electrotechnology, C.S.I.R.O.). The Commission advises on the Commonwealth standards of measurement held at the National Standards Laboratory, Sydney, of the Commonwealth Scientific and Industrial Research Organization.

SIR GEORGE BEILBY Memorial Fund awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made at intervals to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger men and women for original work done over a period of years. In 1949 three such awards were made, each of 100 guineas. Awards may be made early next year, and the administrators request that their attention be directed to outstanding work of the nature indicated not later than December 31. Communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

ERRATUM. In the communication "Monoclinic Thorium Silicate" by Prof. A. Pabst in *Nature* of July 22, p. 157, for the unit-cell dimension $c_0 = 5{\cdot}54$ A., read $c_0 = 6{\cdot}54$ A.

CHEMISTRY OF MUSCULAR CONTRACTION

THE "Chemistry of Muscular Contraction" was discussed jointly by Sections B (Chemistry) and I (Physiology) of the British Association on September 6, during the recent meeting at Birmingham.

Prof. Ernest Baldwin (University College, London) gave an introductory address, stressing the uncertainty of present views on muscle chemistry. He began with a brief historical review from the period beginning with Fletcher and Hopkins's classical experiments to the present day. The work of Fletcher and Hopkins provided the first unequivocal evidence that muscular activity is associated with the degradation of glycogen and the formation from it, under anaerobic conditions, of lactic acid. That glycolysis is not, however, the immediate energy source was discovered by Lundsgaard's demonstration of 'alactic acid' contraction in muscles poisoned with iodoacetate. The activity of iodoacetate-poisoned muscle is attended by the decomposition of phosphagen, glycolysis being totally abolished. Exhaustion of the supplies of phosphagen is promptly followed by rigor, and hence it follows that phosphagen breakdown is a more immediate source of energy than glycolysis.

Phosphagen breaks down rapidly if added to fresh muscle extracts prepared after the method of Meyerhof, but fails to decompose if added to exhaustively dialysed extracts. This, as Lohmann was able to show, was due to the absence from dialysed extracts of adenosine monophosphate. Subsequent work showed that, in fact, phosphagen (creatine phosphate) reacts with adenosine*di*phosphate to yield adenosinetriphosphate and free creatine through the Lohmann reaction, a "phosphate-plus-energy transfer":

$$\text{Creatine phosphate} + \text{adenosinediphosphate} \rightleftharpoons \text{creatine} + \text{adenosinetriphosphate}$$

The involvement of adenosine*mono*phosphate in Lohmann's original experiments was due to the intervention of another enzyme, myokinase.

Since resting muscle contains both adenosinetriphosphate and a powerful adenosinetriphosphatase, but does not contain the di- or mono- phosphate, it seems certain that, in alactic acid contraction as well as in unpoisoned muscle, the breakdown of phosphagen must necessarily be preceded by some breakdown of adenosinetriphosphate to yield the diphosphate. Phosphagen is not known to be broken down in any other way in muscle or in muscle extract, but only by interaction with adenosinediphosphate. Thus the decomposition of adenosinetriphosphate into the diphosphate, inorganic phosphate and energy assumed the position of the earliest known energy-yielding reaction in extracts and probably, therefore, in muscle also.

For this there is at present no direct evidence, and it has not yet been possible to meet A. V. Hill's challenge to biochemists to produce such evidence, mainly because sufficiently refined methods of chemical analysis are not at present available.

The present phase of muscle chemistry began with Engelhart and Lubimova's demonstration, now amply confirmed, of the adenosinetriphosphatase nature of myosin, the predominant protein of muscle, and a protein, moreover, which is known to have contractile properties. Most early preparations of myosin were, however, more or less grossly contaminated with actomyosin, the product of interaction of myosin with a second muscle protein, actin. Actomyosin consists of long, fibrous particles, and much recent research has amply demonstrated the fact that these particles undergo more or less extensive shortening if treated with adenosinetriphosphate, an effect which is exceedingly specific.

Such at present seems to be the physicochemical basis of muscular contraction. In relaxed muscle, both adenosinetriphosphate and actomyosin are present, but are apparently separated in some way until the arrival of a stimulus to contraction. When the two come together the fibres shorten, apparently undergoing dissociation to yield free actin and a myosin–adenosinetriphosphate complex. This latter is, in effect, an enzyme-substrate complex. Only now does adenosinetriphosphate undergo decomposition, yielding, so far as we know, adenosinediphosphate, inorganic phosphate and energy; myosin is regenerated and reacts again with the actin to re-form the longer threads of actomyosin. If this picture is correct, relaxation rather than contraction would have to be considered as the process in which adenosinetriphosphate is broken down, the energy arising from this breakdown being utilized to restore the contracted muscle to its relaxed configuration. The contracted condition, in fact, would seem to be the truly resting state of muscle; a state in which adenosinetriphosphate and actomyosin can perhaps exist as a temporarily stable intermediate reaction complex.

Prof. Baldwin sees in such a theory as this the beginnings of an understanding of the behaviour of the adductor muscles of lamellibranch molluscs, many of which can keep the shells of the animal closed for long periods of time and against relatively enormous loads, yet without any very appreciable consumption of energy. He suggested that more attention might now be profitably paid to these and similar unstriated muscles.

In conclusion, Prof. Baldwin remarked on the frequent revolutions that have already taken place in the field of muscle chemistry, and commented that yet another may be imminent. The picture he had given of the present position was, he pointed out, only one possible interpretation of the experimental facts—something in the nature of an "Aunt Sally", put up in the confident expectation that it would shortly be knocked down.

Dr. S. V. Perry (School of Biochemistry, Cambridge) presented a paper entitled "Adenosinetriphosphate and the Isolated Myofibril". He reminded the audience of the principal structural features of a typical, intact striated muscle. Normal methods of extraction with saline media of low and high ionic strengths extract the sarcoplasmic and myofibrillar constituents respectively, but entail complete structural disorganisation of the tissue. By the use of a collagenase obtained from *Clostridium welchii*, it has been possible, however, to disintegrate only the connective tissues of the muscle and obtain in this way a fine dispersion of intact myofibrils. Their detailed structure was illustrated by a beautiful electron micrograph which showed cross-striations corresponding closely to those of the whole muscle. The micrograph revealed the existence of protein threads, presumably of actomyosin, running through-

out the length of the myofibril and apparently anchored at the *Z* bands. These isolated myofibrils shorten to about 25 per cent of their initial length in the presence of 0·001 *M* magnesium ion and 0·0004 *M* adenosinetriphosphate. A further electron micrograph showed the concertina-like appearance of the shortened myofibril and the disappearance of most of the finer structures originally visible.

The myofibrils decompose adenosinetriphosphate; if they are not carefully prepared, the triphosphate breaks down as far as the monophosphate. Apparently this is due to the presence of myokinase, since repeatedly washed preparations carry the breakdown only as far as the diphosphate. If the muscle is put into rigor by freezing and thawing, there is gross disruption of the structure and normal myofibrils cannot be obtained. Muscles in rigor mortis do not undergo this disruption, and they yield good myofibril preparations. As Dr. Perry pointed out later, the decomposition of adenosinetriphosphate which occurs in rigor mortis, as opposed to that in freeze-thaw rigor, does not appear to be accompanied by the shortening of actomyosin, but may be due to the newly discovered adenosinetriphosphatase of Meyerhof, which appears to be localized in the sarcoplasm and of which the function is still obscure.

Dr. Perry went on to describe experiments which showed that the effects of magnesium and calcium ions on the adenosinetriphosphatase activity of isolated myofibrils differ in some respects from the effects obtained with extracted actomyosin. Isolated myofibrils also show differences from artificial threads made from actomyosin in their physical behaviour with adenosinetriphosphate; in particular, the shortening of actomyosin threads is essentially dehydrative and is isodimensional. That of the myofibrils, however, is longitudinal, with little or no lateral change, and thus more closely resembles normal muscle contraction. These differences, Dr. Perry believes, are due to differences in the structural organisation of the two kinds of preparations. He then passed on to discuss possible relationships between the enzymic and structural organisation of the muscle cell on one hand and the phenomenon of cellular contractility on the other. In the main, these appear to be in agreement with the general picture previously given by Prof. Baldwin.

Dr. J. R. Bendall (Low Temperature Research Station, Cambridge), in a paper entitled "Shortening of Muscle in rigor mortis", chose to assume that the contraction of a muscle passing into rigor mortis can be considered as a very protracted and irreversible form of muscular contraction, though he was well aware of the dangers which this assumption implies. Mammalian (rabbit psoas) muscle going into rigor does not shorten much at room temperature, but is capable of doing a good deal of mechanical work at higher temperatures (37°) and especially at high *p*H (7·25). This shortening and work-performance are associated with three chemical phenomena known to occur in normal muscle, namely: (*a*) fall of *p*H due to lactic acid formation, which can be minimized by using starved or paralysed animals; (*b*) breakdown of phosphagen; and (*c*) breakdown of adenosinetriphosphate.

A number of slides in which the magnitudes of these three phenomena were plotted against time, together with plots of the degree of shortening, all on a percentage basis of the initial values, were shown by Dr. Bendall. The rate of shortening and the amount of work done is higher at higher *p*H, but neither the rate of *p*H change nor that of phosphagen breakdown parallels the rate of shortening. On the other hand, the breakdown of adenosinetriphosphate begins at about the same time as the onset of shortening, and the two processes are well correlated. The disappearance of phosphagen in spite of vigorous glycolysis is almost complete before adenosinetriphosphate breakdown assumes major proportions. Shortening is never found to begin before adenosinetriphosphate breakdown.

If Dr. Bendall's assumption be correct, his results would indicate that the breakdown of adenosinetriphosphate is associated with the phase of shortening rather than with that of elongation in normal muscle, a conclusion diametrically opposed to the scheme proposed by Prof. Baldwin. Dr. Bendall pointed out that his observations would account for the thermal data obtained by Prof. A. V. Hill if his initial assumption were true.

There were few comments and little discussion, apart from some observations on the properties and behaviour of artificial threads of actomyosin and myosin, which took place mainly between the speakers themselves. It appeared that the behaviour of actomyosin threads, free to shorten or placed under load, can be accounted for by the known properties of actomyosin, and that some important differences between these threads and isolated myofibrils can be attributed to differences in the orientation of the actomyosin fibres in the two cases. Prof. Baldwin, in concluding the discussion, said there had been much more agreement between himself and his fellow contributors than he had expected, and he was particularly interested in the contrasts between Dr. Perry's myofibrils and artificial actomyosin fibres of varying degrees of orientation.

SCIENTIFIC INTERESTS OF ADULTS*

By W. E. FLOOD

Education Department, University of Birmingham

THE investigations described here form part of a wider study of the techniques of presenting science, by book or lecture, to the ordinary, non-academic adult. Exploratory examinations were made of the relative interest in the various branches of science and of the relative appeal of different lines of approach to scientific topics.

A new classification of twenty-three science 'subjects' was devised for the investigation of interests. This included the recognized branches of science (for example, astronomy, geology) and also certain aspects of science such as industrial applications, new discoveries, scientific biography, and public direction and use of science. The interpretations to be placed on the twenty-three subject headings were briefly explained on the test-sheets used in the inquiries.

At this early stage of the study it seemed desirable to examine the preferences of adults who have revealed some definite interest in science. A test-group of about four hundred adults (called Group I) was constructed from people voluntarily attending science lectures provided by the Workers' Educational Association (and a few by university extra-mural departments) in various parts of the country. They

* Substance of a paper read on September 1 before Section J (Psychology) of the British Association meeting at Birmingham.

were asked to indicate their degree of interest in each of the twenty-three subjects on a five-point scale ranging from *A* (this interests me very much) to *E* (this does not interest me at all).

The distribution of the *A*, *B*, *C*, *D*, *E* markings in any one subject usually indicated a definite central tendency, though in a few subjects the weight was largely concentrated at one end or other of the scale. In no case was there weight at both ends of the scale with a minimum between.

Differences between the markings in the twenty-three subjects, and between the markings by each sex, were analysed by chi-square methods. For the purpose of simple presentation of the results, a numerical interest-rating was evaluated by assigning 100, 75, 50, 25, 0 to the markings *A*, *B*, *C*, *D*, *E* respectively and taking the average. The results so obtained, when compared with those obtained by more rigorous methods, were found not to be misleading.

The average interest-rating for the twenty-three subjects was 58 for both sexes, that is, rather above *C* (moderate interest). The male interest was greatest in future trends and possibilities (77) and new discoveries (74). Industrial applications and medicine, disease and health were also popular. There was little interest in aeronautics (35), in public use of science, and in text-book fundamentals. Females indicated greatest interest in medicine, disease and health (85) and pure biology (83). Psychology and applied biology occupied the next places. They, too, ranked aeronautics of least interest (24), and expressed little interest in the several branches of engineering and in radio.

The most striking sex-difference was the wider range of interest-ratings shown by females (males 77–35, females 85–24). The range was most marked in the 20–40 age-group (psychology 92, aeronautics 22). Females appear to be more extreme in their preferences. The male interest was significantly higher in text-book fundamentals, branches of engineering, aeronautics, and future trends—subjects mainly associated with general usefulness and vocation. Female interest was significantly higher in medicine and health, pure and applied biology, psychology, biography, and anthropology—all subjects associated with 'life'. A curious result was a higher female interest over Group I in meteorology.

A similar investigation was carried out with the better classes of men in an Army education unit. These men were not necessarily interested in science at all. The average for all subjects was 55, but possibly this arose from a desire to please. In more than half the subjects the interest-ratings were very similar to those of the men in Group I. This suggests that the results for Group I may be representative of a wider range of the public. The Army men, as might be expected, were more interested than men of Group I in mechanical engineering, aeronautics, and radio, but were much less interested in biology, astronomy, and geology.

A scientific topic, presented in a book or lecture, can often be approached from a number of angles. Six possible approaches (or points of view) were identified for study. An examination was made of the preferences of the adults in Group I. It was found that both males and females prefer a presentation built around the direct effects of the topic on the individual. They also liked approaches through the pure science of the topic and through future hopes and possibilities. They expressed very little interest in historical, biographical, and dramatized approaches and in presentations based upon the interplay of science and social life.

The test was repeated with about four hundred students (both sexes) in emergency training colleges. About fifty of these were taking science in their course (but not to an advanced standard). This sub-group showed a very strong preference for approaches through practical applications and expressed some interest in the pure science of a topic. They were not so interested in future trends, but more interested than Group I in social interactions. There was practically no support for a purely historical approach. The remaining 350 students were not studying science, and possibly were not interested in it. They felt that they would be most interested by approaches through direct applications (but less strongly than previous groups) and, of special importance, welcomed approaches through history, biography, and social interactions. Approaches through pure science and future trends would meet with little success.

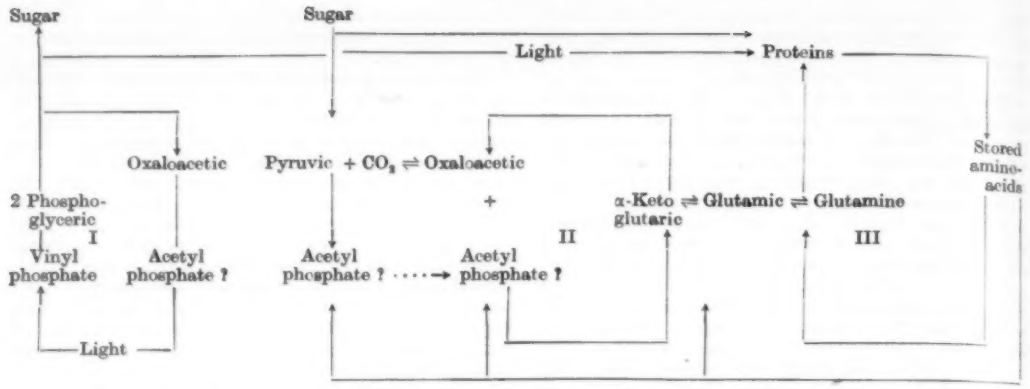
It seems that adults who know some science (as probably did those in Group I) prefer a presentation 'undiluted' by history and social effects; but those who know little science are more likely to be interested in a presentation based upon history and upon the effects of science on the individual and society.

PHOTOSYNTHESIS AND RESPIRATION: A REINTERPRETATION OF RECENT WORK WITH RADIOACTIVE CARBON

By Prof. F. C. STEWARD and Dr. J. F. THOMPSON
Cornell University, Ithaca, New York

CONCERNING the old, but still challenging, problem of the first product of photosynthesis and the subsequent path toward sugar, two different groups of workers have recently reached different conclusions.

The active California group, led by Calvin and Benson[1,2,3], conclude that the immediate receptor of carbon dioxide is a two-carbon compound (vinyl phosphate), the formation of which is stimulated by light, and the first fixation product to be identified is a relatively simple substance (2-phosphoglyceric acid). According to Calvin and Benson, the course of metabolism of green cells in the light is quite different from that which obtains in the dark. Calvin discredits the old view that respiration in green cells in the light proceeds relatively unaffected by their concomitant photosynthesis and, from the experimental data, now concludes that respiration in the light is arrested. Metabolism, which in the dark proceeds through a Krebs-type carboxylic acid cycle culminating in the production of carbon dioxide, is regarded as diverted in the light to proceed through another cyclical process leading to the fixation of carbon dioxide and the synthesis of carbohydrates by the reversal of glycolysis. This novel scheme embodies several salient features:



Cycle I. Simplified from Calvin[1].
Cycle II. Simplified Krebs cycle.
Cycle III. See ref. 9 and references there cited.

(1) The receptor of carbon dioxide is formed in the light and is a simple two-carbon compound.

(2) The subsequent fixation of carbon dioxide is not specifically light-activated; in fact, all the reactions of carbon may occur in the dark if the cells are first stimulated by light.

(3) There is a contrasting relationship between respiration (occurring only in the dark and visualized as though it proceeds only through a carboxylic acid cycle) and photosynthesis (which stems from the light-activated 2-carbon intermediate). Respiration and photosynthesis are regarded as mutually exclusive. This is shown by the accompanying figure, in which the cyclical processes I and II are simplified and adapted from Calvin[1]. The cyclical process I occurs only in the light, and the familiar cyclical process II occurs only in the dark, according to Calvin.

In sharp contrast stand the results of the Chicago school[4,5]. Their findings are interpreted to mean that the first product of photosynthesis is a relatively stable substance—not a simple one—but one which, though it remains unidentified, can be isolated and examined by extraction procedures which are described. According to the Chicago school, the essential intermediates of photosynthesis are unique, and the essential steps of the light process cannot be interpreted by reference to dark fixation, which is regarded as a completely separate process unrelated to the essential step of photosynthesis.

In each case, the laboratories in question have utilized radioactive carbon dioxide, and each case is supported by impressive evidence. The problem now becomes one of interpretation. The following analysis attempts to place some of this work in a different perspective, and this may afford some aid toward resolving the discrepancy between the two schools. The lesson to be learnt is, however, that photosynthesis is not merely an isolated chemical problem. As it proceeds *in vivo* it occurs in a milieu capable of, in fact obliged to, carry out numerous other metabolic processes which are consistent with the maintenance and the growth of cells. Our thesis is that the interpretations obtained by the Calvin school have ignored the concomitant processes of protein synthesis and breakdown, and in so doing have drawn conclusions which are physiologically improbable.

One must first emphasize some features of nitrogen metabolism in plants which are familiar to plant physiologists and easily verifiable from the literature. These are as follows:

(1) The green leaf—or the green cell—in the light is a prominent region of protein synthesis: not because light enters into the reactions of protein synthesis *per se*, but rather because the green cell in the light is well supplied with the substances necessary for protein synthesis. These may be either sugars or the intermediaries of sugar synthesis by photosynthesis. In fact, it has been suggested that protein synthesis in the green leaf may proceed by a different mechanism than in the case of cells which are not green[6,7].

(2) Rapid synthesis and breakdown of protein is to be regarded as a constant feature of plant, as well as of animal, cells even where the actual content of protein remains steady by balancing the rates of breakdown and of synthesis[8].

(3) Glutamic acid is believed to hold a very special position in nitrogen metabolism—so much so that it has been suggested that the free amino-acids are not merely linked up to form protein; but that they constitute a ready reserve of organic nitrogen which becomes available for synthesis inasmuch as it is released by oxidative deaminations or is transferred by transaminations and the nitrogen is canalized through glutamic acid or glutamine en route to protein—glutamic acid being regarded as the ultimate donor of the nitrogen actually incorporated into protein[9].

(4) The association of a carboxylic acid respiratory cycle with a nitrogen cycle of synthesis and breakdown is a necessary and now familiar way of emphasizing the role of amino-acids in furnishing substrates for respiration, and of respiration and sugar metabolism in furnishing the energy, the carbon skeletons and the impetus for protein synthesis. Such schemes utilize the fact that α-keto-glutaric acid and glutamic acid constitute the major link between carbon compounds involved in respiration and nitrogen compounds involved in nitrogen metabolism[9,10,11,12].

(5) Carboxylation (at the level of pyruvic acid–oxaloacetic acid) plays a key part in maintaining the Krebs carboxylic acid cycle. Some circumstances tend to maintain a very low level of carbon dioxide and to foster decarboxylations; for example, especially efficient aeration with carbon dioxide-free air of submerged cells and tissues have been shown to

stimulate protein synthesis in cells which are not green (cells of storage organs). Conversely, aeration, coupled with an external supply of carbon dioxide, can completely suppress protein synthesis[13]. These facts were later construed to mean that pCO_2 played a regulatory part in respiration and protein synthesis[9]. When the reactions of carboxylation were blocked by lack of free carbon dioxide, and decarboxylations fostered, the carboxylic acid cycle could only be maintained by supplying α-keto-glutaric acid from glutamic acid in lieu of pyruvic acid. This, in effect, diverted sugar metabolism from pyruvic acid and respiration via the carboxyl acid cycle to protein synthesis, utilizing the nitrogen donated by amino-acids, particularly glutamic acid and glutamine. Thus, the conditions for synthesis of protein coincided with low internal concentrations of carbon dioxide. These conditions have been achieved by rapid aeration with carbon dioxide-free air in non-green cells, though the interesting possibility was raised that the same mechanism might operate to foster protein synthesis in the light in green cells[9].

These relationships, visualized in terms of an interlocking carboxylic acid cycle and a nitrogen cycle, are shown in the form of Cycles II and III of the accompanying simplified scheme. The purpose of this scheme is to stress that deaminated residues of amino-acids may enter the carboxylic acid cycle and contribute to respiration, while the nitrogen groups may be recondensed to protein, utilizing a carbon framework derived ultimately from sugar or its precursors. Furthermore, the conditions of low carbon dioxide tension, such as prevail in green cells in the light, divert the metabolism from the use of sugar, via pyruvate, in the carboxylic acid cycle to the use of α-keto-glutarate from glutamic acid.

The unconventional views of Calvin and his co-workers on the balance of respiration and photosynthesis rest briefly upon the following observations:

(1) $C^{14}O_2$ applied to *Chlorella* and other green cells only enters glutamic acid and the intermediates of the Krebs cycle (succinic, fumaric, isocitric) in the dark, and moreover when the dark fixation occurs in cells not previously stimulated by exposure to light.

(2) The dark fixation which occurs after previous light stimulation is in all essential respects identical with ordinary photosynthesis.

(3) In the light $C^{14}O_2$ enters into combination with a light-stimulated intermediate (vinyl phosphate) and passes through 2-phosphoglyceric acid en route to sugar—all these reactions being possible in the dark granted the supply, by previous light stimulation, of the two carbon receptors.

(4) There is a number of substances, aspartic acid, serine, alanine, malic acid, the general occurrence and content of carbon-14 of which, both in the light and the dark, are attributable to their ready derivation from pyruvic or oxaloacetic acids.

(5) The two-carbon light-stimulated intermediate (vinyl phosphate) is hypothetical, but a compound which releases radioactive acetaldehyde on heating for 10 min. with dilute acid occurs.

The Calvin group postulates that the carboxylic acid cycle is suppressed in the light because acetate or acetyl phosphate, a necessary reactant with oxaloacetic, is kept by light in the form of vinyl phosphate which cannot enter the Krebs cycle.

There is no proof that respiration proceeds *only* through a Krebs cycle, as Calvin *et al.* seem to suggest. Even so, however, there is an alternative interpretation of the experimental facts brought forward by the Calvin school; this follows by combining the ideas embodied in Cycles I and II with those of Cycles II and III, as shown in the figure. These ideas are as follows:

(1) Of necessity, the carboxylic acid cycle of respiration proceeds in green cells *both* in the light and in the dark, but with different substrates furnishing the carbon source. It is inconceivable that green cells in the light do not respire.

(2) In the light, growth and synthesis of protein predominate over its breakdown; the carboxylation reactions of the carboxylic acid cycle are eliminated by the low internal pCO_2*, and this cyclic process is now maintained by the carbon residues fed into it from amino-acids. Meanwhile, the nitrogen groups pass to protein utilizing carbon compounds which are either en route to, or from, sugar (that is, compounds which, under these conditions, are diverted from respiration to protein synthesis). Therefore, carbon-14 supplied as $C^{14}O_2$ to green cells in the light would not be expected to enter into the composition of glutamic acid and the intermediates of the carboxylic acid cycle *until after it had been incorporated into protein* and until appreciable protein breakdown had occurred.

(3) In the dark the carboxylic acid cycle is maintained in the usual way from the products of glycolysis (Cycle II of the figure), and on the addition of $C^{14}O_2$ the intermediate compounds of this cycle (and the amino-acids derivable from them, especially glutamic acid) readily become radioactive by dark fixation.

(4) The ready occurrence of carbon-14 in glutamic acid when the $C^{14}O_2$-treated *Chlorella* cells are in the dark and its comparative absence when the cells are in the light have, therefore, more direct significance for the problem of nitrogen metabolism than for the problems of respiration and photosynthesis *per se*. These observations are compatible with the generally accepted view that the green cell in the light is a potent centre of protein synthesis (because the green cell in the light has access to photosynthetic intermediates as well as to products of nitrate reduction and now because the low pCO_2, caused by the photosynthesis itself, will draw the carbon skeletons of amino-acids, via glutamic acid, into the respiratory cycle and divert their nitrogen groups into protein).

Therefore, the interpretation of what the Calvin school has shown may *not* be that the Krebs cycle and respiration are suppressed by light, but rather that, under these conditions of reduced carbon dioxide tension in the cells, these processes utilize carbon sources drawn from amino-acids rather than sugar.

These relationships may be visualized in the combined scheme of the figure. The argument of Calvin *et al.* is that Cycle II ceases in the light. Our view is that, in the light, Cycle II is maintained from glutamic acid and the deaminated residues of amino-acids, and that the light-stimulated protein synthesis uses carbon from photosynthetic intermediates and nitrogen groups donated by glutamic acid. A still more recent summary by Benson and Calvin[14] makes this point of view reasonable, for these authors write (l.c., p. 30): "The major portion of the insoluble products formed in the first few minutes by algæ . . . was protein. Acid hydrolysis produced radioactive amino-acids in approximately the same relative amounts as those in the cell extract. Protein obtained

* The only treatments of Calvin *et al.* which could have produced a low carbon dioxide tension in the cells by means other than photosynthesis were those where they used a 'helium sweep' which would also produce, especially in the dark, anaerobiosis: this would also tend to limit protein synthesis.

from longer experiments (5 to 10 min.) contained more activity than that found in several amino-acids present in the cell extracts. Glutamic acid, by far the largest free amino-acid reservoir, was not converted into protein in amounts commensurate with its concentration." This seems to be consistent with the fundamentals of our interpretation, namely: (1) protein is formed rapidly in the light and contains carbon-14 furnished as $C^{14}O_2$; (2) glutamic acid is present in large amounts; (3) all the *carbon* of the glutamic acid does not go into the protein, though the nitrogen, which was not labelled, may.

The outstanding contribution of the Calvin school to our knowledge of photosynthesis is the recognition that 2-phosphoglyceric acid is a product of $C^{14}O_2$ fixation in the light or, after light stimulation, in the dark. This result will have far-reaching consequences. However, the Calvin school has interpreted its other results in ways which are physiologically improbable, and in so doing seems to have overlooked possibilities based on other concomitant physiological processes, which enable its data to be interpreted in other ways. In this brief analysis we have tried to show certain of these possibilities.

Finally, photosynthesis as it proceeds *in vivo* occurs in a system capable of protein synthesis: to understand one process we may need to comprehend more of its relations to the other. There may be a clue here also to the behaviour of isolated chloroplasts for, so far as is known at the present time, they are incapable of growth and division and they are also incapable of reducing carbon dioxide.

[1] Calvin, M., Reilly Lectures, **2**, 1 (University of Notre Dame, 1949).
[2] Benson, A. A., and Calvin, M., *J. Exp. Bot.*, **1**, 63 (1950).
[3] Calvin, M., *J. Chem. Ed.*, **26**, 639 (1949).
[4] Brown, A. H., Fager, E. W., and Gaffron, H., "Photosynthesis in Plants", p. 403 (Iowa State College Press, 1949).
[5] Fager, E. W., *ibid.*, p. 423.
[6] Burström, H., *Ann. Agric. Coll. Sweden*, **11**, 1 (1943).
[7] Burström, H., *Ann. Agric. Coll. Sweden*, **15**, 1 (1945).
[8] Vickery, H. B., Pucher, G. W., Schoenheimer, R., and Rittenberg, D., *J. Biol. Chem.*, **135**, 531 (1940).
[9] Steward, F. C., and Street, H. E., *Ann. Rev. Biochem.*, **16**, 471 (1947).
[10] Chibnall, A. C., "Protein Metabolism in the Plant", 306 (Yale University Press, New Haven, Conn., 1939).
[11] Gregory, F. G., and Sen, P. K., *Ann. Bot.* (N.S.), **1**, 521 (1936).
[12] Vickery, H. B., and Pucher, G. W., *J. Biol. Chem.*, **128**, 685 (1939).
[13] Steward, F. C., and Preston, C., *Plant Physiol.*, **16**, 481 (1941).
[14] *Ann. Rev. Plant Physiol.*, **1**, 25 (1950).

CINEMATOGRAPHIC RECORDING OF THE VELOCITY OF ARTERIAL BLOOD-FLOW[1]

By J. M. POTTER and D. A. McDONALD

Dept. of Physiology, St. Bartholomew's Hospital Medical College, London

THE direct study of blood-flow in intact arteries is difficult for two main reasons: the thickness and opacity of the vessel walls, and the relatively high velocity of flow within them.

We have developed a technique in which these difficulties are reduced. The arteries within the cranium and vertebral canal have thin walls in proportion to their diameters. Among these arteries is the basilar, which in the rabbit is some 1·5 cm. in length with an external diameter of approximately 1 mm. It has been exposed in its proximal half and its contents examined through its translucent wall with a dissecting microscope.

The basilar artery is formed by the fusion of the two vertebral arteries, each of which is rather more than half the calibre of the basilar. We have shown[2] the flow in it to be streamlined (laminar), because dye introduced into one vertebral artery remains in a distinct stream on its own side in the basilar.

In order to measure the velocity of flow in the artery, we have recorded cinematographically the passage of injected substances along it. This has been done with the 'Kodak' high-speed camera which works at speeds up to 3,000 frames per sec. Extension tubes were used so that the object : image ratio was 3 : 4. The light source was a 500-watt 'Osira' high-pressure mercury arc-lamp, focused by a condenser and projected into the field by a mirror from a Watson's microscope strapped to the lens-extension tube system. To avoid overheating the preparation, 'Calorex' glass was interposed, although this entailed a loss of light of some 15 per cent. The effective efficiency of the 'shutter' system of the camera was about 20 per cent, so that at 3,000 frames per sec. the effective exposure was 1/15,000 sec. (The camera actually has no shutter; the film is traversed continuously behind a revolving block of glass.) The provision of sufficient light was therefore the outstanding technical difficulty in photographing blood. Originally a cadmium-mercury lamp was used; but the red in it was not effective enough to contrast dark dyes with blood under the experimental conditions, that is, relative under-exposure, and using a heat filter which was slightly green. Therefore, it was necessary to photograph the blood as black, and introduce contrasting substances that photographed white.

Successful results were obtained using 0·05 per cent fluorescein solution, and globules of olive oil (stabilized with 'Teepol'). Injections were made into the axillary artery some 6 cm. nearer the heart. The smallest globules seen were estimated at 0·07–0·08 mm. and the largest about 0·2 mm. As they had to pass up the vertebral artery, which has an internal diameter of about 0·5 mm., this was considered to be satisfactory.

The film is marked in the margin with a time-base produced by an electrically maintained 500-d.v. tuning-fork. Most of our results were obtained at 1,500 frames per sec. Analysis of the velocity of flow was done both by measuring time taken to traverse successive millimetres of the artery, and by measuring the distance travelled during various periods of time

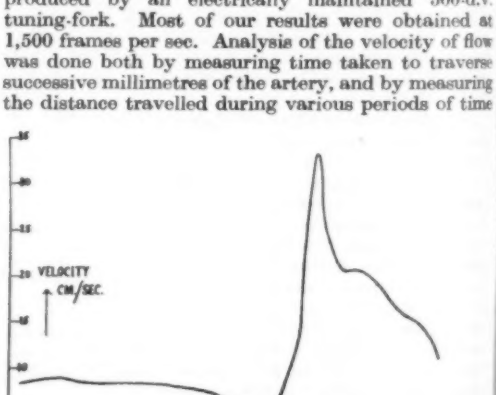


Fig. 1. Changes in velocity during approximately one cardiac cycle

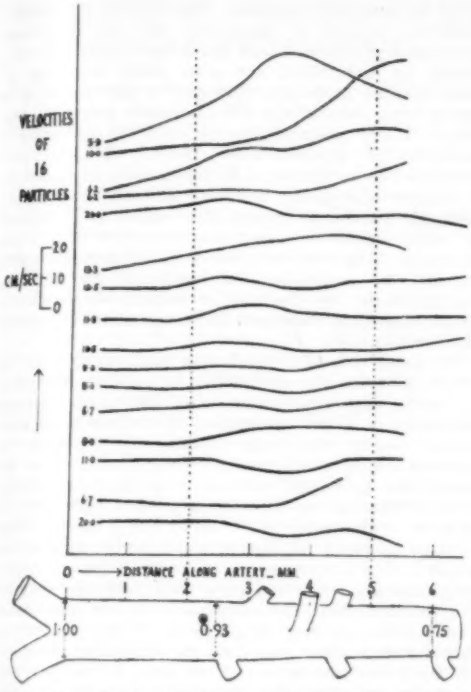


Fig. 2. No constant change in velocity in relation to branching (between dotted lines). The initial velocity of each particle is shown against its curve

(10 msec. during the phases of slow flow, and down to 2 msec. where rapid changes were occurring.) The intervals between the arrival of each particle were recorded and a composite graph of the velocity changes throughout a cardiac cycle has been built up from the behaviour of successive oil globules (Fig. 1). That the globules are not themselves significantly affecting the velocity is suggested by the fact that we have not detected any constant difference in the velocities of the smallest and largest globules in the series.

Thus in the rabbit basilar artery it may be seen that there is a period of rapid acceleration lasting some 15–20 msec. when the velocity increases from 5 to 33 cm. per sec. (40 cm. per sec. in another series). There is then a sharp fall to a plateau of some 20 cm. per sec. with probably a dicrotic notch intervening. Thereafter the velocity declines throughout the rest of diastole. The exact duration of the cardiac cycle could not be measured but was of the order of 200 msec. (300 beats per minute).

That the acceleration or deceleration is not related to the conformation of the artery is shown by Fig. 2. This shows that the changes in velocity of sixteen particles as they pass along bear no constant relation to the position of the branches.

We consider it worthy of note that the velocity 'spike' is so sharp even after traversing the long, narrow and presumably elastic vertebral artery. The end of this artery that we are observing is more than 100 diameters from the heart. Furthermore, even at this distance the velocity at a given moment is dependent on its relation to cardiac systole and not to the presence of branching.

It is perhaps also worth while considering what is meant when one refers to 'arterial velocity'. Since the flow is pulsatile there is a maximum and a minimum velocity, and the latter may be a negative value in arteries (not this one apparently) where there is a brief phase of retrograde flow[3]. An integrated mean velocity value must therefore be obtained for the whole cardiac cycle (from Fig. 1 it is approximately 12 cm. per sec.).

This is non-specifically *linear* velocity; but since the flow is in addition streamlined, then what one might term a mean *laminar* velocity is further required if the volumetric rate of flow is to be calculated. In our method the velocities obtained are presumably those of the more axial streams, depending on the size of the globule.

It is thus difficult to calculate the volumetric rate of flow from our measurements of velocity. Equally, we suggest that deductions concerning arterial velocity derived from volumetric rates have little significance.

This cinematographic method, although expensive and not easily available, is the only one we know that can be used in an artery of this size. It avoids instrumental interference and problems of inertia. It may have further scope in investigating physiological problems.

We are indebted to Kodak Research Laboratories for the cinematography. This was done by Mr. John Hadland, who also supplied certain technical details quoted. [Aug. 14.

[1] A preliminary communication. The films obtained were shown in July 1950 to the Physiological Society at Oxford and to the first International Colloquium for Rheological Problems in Biology at Lund, Sweden.

[2] McDonald, D. A., and Potter, J. M., *J. Physiol.*, **109**, 17*P* (1949).

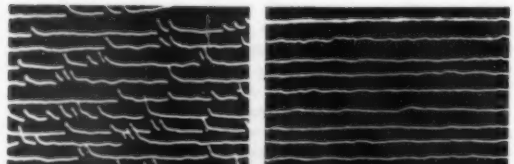
[3] Shipley, R. E., Gregg, D. E., and Schroeder, E. F., *Amer. J. Physiol.*, **138**, 718 (1943).

SOME OBSERVATIONS ON BIOLOGICAL NOISE

By Dr. P. FATT and Dr. B. KATZ

Biophysics Research Unit, University College, London

MOST biological reactions occur on such a large scale that they remain unaffected by the random fluctuations of participating molecules or energy quanta[1]. There are, however, exceptions to this rule: for example, visual threshold measurements depend upon fluctuations in the number of light quanta which strike the receptor cells[2]. In this article observations are described which suggest that electrical random noise in fine nerve structures may produce important physiological effects. Excitation of a nerve cell occurs when its membrane potential has suffered a sudden critical displacement[3]. Owing to thermal agitation of ions, the resting potential of the cell does not remain at a constant level, but what we measure is, in fact, an average level subject to small statistical fluctuations. If these fluctuations reach an amplitude of the order of millivolts, they may be expected to produce physiological responses. The magnitude of the noise voltage fluctuation depends upon the cell size, and a simple calculation indicates that in a 100-μ muscle fibre the noise has an r.m.s. voltage of only about 1 μV., but would approach 1 mV. in a very fine nerve ending of, say, 0·1 μ diameter. It is at the level of nerve terminals



(a) (b)

An example of end-plate noise, recorded from a fibre of the musculus extensor longus dig. IV of the frog: upper portion, spontaneous potential changes recorded on a slow time base with high amplification; lower portion, response to a motor nerve impulse, recorded on a fast time base with low amplification. (*a*) electrode inserted at an end-plate; (*b*) electrode 2 mm. away, in the same muscle fibre. Voltage and time scales represent 3·6 mV. and 47 m.sec. for the upper part, and 50 mV. and 2 m.sec. for the lower part

and nervous synapses that effects of ionic noise should be searched for, and the following observation appears, therefore, relevant.

When a micro-electrode is inserted into the nerve-free part of a frog muscle fibre, a potential difference of about 90 mV. is recorded across the fibre membrane[4]. There is no sign of electric activity other than small disturbances due to the ordinary sources of noise in electrode and amplifier. A very different picture is obtained when the electrode is inserted immediately under the motor nerve endings (see accompanying photographs).

There is local activity of a characteristic nature: small action potentials of rapid rise and slow decay follow one another at random intervals. These discharges occur in discrete sizes, indicative of a number of separately firing units. These responses can be regarded as miniature 'end-plate' potentials[5], and, like the ordinary end-plate potential, they are abolished by curarine and increased in size and duration by prostigmine. In fact, they are distinguished from the familiar end-plate potential only by their spontaneous and random occurrence and by their miniature size, which is about 1 per cent of the electric end-plate response to a motor nerve impulse. The phenomenon may conveniently be called 'end-plate noise'. It appears to be present at the majority of end-plates in frog muscle; but its average frequency varies greatly from fibre to fibre, between less than 1 per sec. and about 100 per sec., at 20° C. The rate of the discharge is greatly affected by physical changes—for example, small alterations of temperature, and of osmotic pressure, have a profound effect.

It is very probable that, like the ordinary end-plate potential, these spontaneous sub-threshold effects are due to the release of small quantities of acetylcholine from motor nerve terminals, the difference being due to the activity of isolated terminal spots rather than to a synchronous discharge from the whole terminal apparatus. It is known that acetylcholine is continually synthetized at the nerve endings[6], and the end-plate noise might perhaps be attributed to a bombardment of the motor end-plate by individual molecules of acetylcholine which escape from the nerve terminals. This simple hypothesis, however, cannot be accepted, for the individual spontaneous responses are much too large to be produced by individual, or even small numbers of, acetylcholine molecules (the size of the responses is about 1 per cent of the full end-plate potential, and this is due to the action of at least 10^4 molecules of acetylcholine, possibly much more). A more direct argument is as follows. If the muscle is soaked in a solution containing 3×10^{-7} *M.* acetylcholine, the resting potential of the end-plate region is diminished by several millivolts, but the recurrence-rate of the end-plate noise remains unaltered. Clearly, it cannot be due to molecular bombardment by escaping acetylcholine, for the rate of such a bombardment must be greatly increased in the presence of applied acetylcholine.

We must therefore think of a local mechanism by which acetylcholine is released at random moments, in fairly large quantities; and the most plausible explanation is the occurrence of excitation at individual nerve terminals, evoked by spontaneous fluctuations of their membrane potential. Once the membrane potential has been displaced sufficiently, local excitation occurs within a very brief interval of time, of the order of 10^{-4} sec.; but it does not lead to a propagated impulse if the affected area is too small[7]. The recurrence intervals between successive responses are relatively very long, and this suggests that, statistically, the response is a very improbable event (that is, the mean level of the underlying fluctuation is much less than the excitation threshold of the nerve terminals). Now, it is a characteristic property of such statistically improbable trigger-actions that their recurrence-rate is greatly affected by small changes of the threshold, or of the mean energy-level, of the system, and this may well explain the great differential sensitivity of our phenomenon to relatively small physical alterations (a 50 per cent increase in osmotic pressure, for example, produced a reversible increase in the rate of discharge from 2 per sec. to 90 per sec.).

It is possible that the phenomenon here described is of a much more widespread occurrence, and it will be worth looking for similar effects at fine nerve endings, sensory and synaptic, elsewhere in the nervous system. While, in this particular case, local activity evoked by random changes in the motor nerve endings remained always well below the threshold of propagation, it appears that there are pathological conditions under which this phenomenon becomes exaggerated and leads to functional disorder—for example, the twitching during eserine poisoning[8] and under the influence of tetanus toxin[8]. But the concept of local excitation being caused by peak voltages of membrane noise may be of wider application, and it is possible that such events play an important part in the production of spontaneous activity at neuronal synapses and sensory nerve endings.

[1] Schrödinger, E., "What is Life?" (Cambridge University Press, 1944).

[2] Pirenne, M. H., "Vision and the Eye" (Pilot Press, 1948).

[3] Hodgkin, A. L., *Proc. Roy. Soc.*, B, **126**, 87 (1938). Hodgkin, A. L., *J. Physiol.*, **107**, 165 (1948). Katz, B., "Electric Excitation of Nerve" (Oxford University Press, 1939).

[4] Ling, G., and Gerard, R. W., *J. Cell Comp. Physiol.*, **34**, 383 (1949). Nastuk, W. L., and Hodgkin, A. L., *J. Cell. Comp. Physiol.*, **35**, 39 (1950).

[5] Eccles, J. C., Katz, B., and Kuffler, S. W., *J. Neurophysiol.*, **4**, 362 (1941), and **5**, 211 (1942).

[6] Feldberg, W., *J. Physiol.*, **103**, 367 (1945).

[7] Rushton, W. A. H., *Proc. Roy. Soc.*, B, **124**, 201 (1937).

[8] Harvey, A. M., *J. Physiol.*, **96**, 348 (1939).

THE LONDON CONFERENCE ON OPTICAL INSTRUMENTS

THE London Conference on Optical Instruments, held at the Imperial College of Science and Technology during July 19–26, was timed to follow the meetings of the International Optical Commission, and was attended by nearly all the delegates of the latter. This helped to give a genuinely international flavour to a very successful series of meetings.

The declared object of the Conference was "to obtain a survey of modern practice and trends in the construction of actual instruments"; but the proceedings also included symposia on the diffraction theory of optical instruments and on phase-contrast microscopy, and from the scientific point of view these were the most interesting sessions. Also noteworthy were the papers and discussions on reflecting microscopes; here the interest was mainly technological.

After the opening address by Sir Thomas Merton, president of the Conference, an account was given by Prof. S. S. Ballard of recent optical developments in the United States. Next, M. A. Maréchal (Paris) spoke about recent French researches on diffraction in optical instruments and showed interesting slides of particular cases of diffraction patterns, calculated on his integrating machine in the Institut d'Optique, associated with aberrations amounting to several wave-lengths, that is, of amounts not at present easy to deal with by more analytical methods.

Dr. H. H. Hopkins described some investigations of his own into partial coherence and its connexion with microscopic resolution. Mr. Barham gave an account of his joint paper with Dr. Hopkins entitled "The Influence of Condenser Aperture on Microscopic Resolution".

Dr. E. Wolf then spoke about his recent work on the three-dimensional distribution of light in diffraction images near focus; this work has some important applications to the theory of telescopic star images. Dr. E. H. Linfoot described in outline how diffraction theory could be applied to discuss the systematic errors inherent in phase contrast testing with a slit-source; his main result was that these errors do not impair the usefulness of the test for ordinary purposes.

The second day, July 20, was devoted to purely technical accounts of certain newly designed lenses for photography and for television. Mr. R. Kingslake (Eastman Kodak) described some recent developments of photographic objectives in the United States. Dr. Hopkins spoke about the 'zoom' lenses on which he has been working recently, and Mr. Warmisham (of Taylor, Taylor and Hobson, Ltd.) described a new $f/1$ objective with an 18° spherical field, intended primarily for radiology. A reception at the Royal Institution, followed by a discourse on phosphorescence by Prof. E. N. da C. Andrade, concluded the day.

July 21 was occupied by visits to the National Physical Laboratory and to other centres of optical activity.

On July 24 the proceedings began with a general survey by Dr. R. Barer, entitled "Practical Requirements in a Reflecting Microscope". Dr. A. Bouwers (Delft) followed with an account of the concentric mirror microscopes recently put on the market by his firm. Finally, Mr. D. S. Grey (Polaroid Corporation, U.S.A.) spoke on catadioptric microscopes.

In the afternoon, Prof. Curtis, Dr. G. R. Harrison and Mr. C. L. Bausch (Massachusetts Institute of Technology), Dr. E. Ingelstam and Dr. E. Hulthén (Sweden), and Mr. E. Lind (University of Stockholm) read papers on various aspects of grating spectroscopy.

July 25 was mainly devoted to phase contrast microscopy. Papers were given by Prof. F. Scandone (Italy), Mr. F. W. Cuckow, and Dr. M. Françon (France), the last of whom described with rapidly and beautifully executed blackboard drawings his interesting devices for adapting standard microscopes to phase contrast work by the addition of an auxiliary optical system in front of the objective. Mr. E. Bergstrand (Sweden) discussed work on the velocity of light and the measurement of distances by a development of the Kerr cell method which uses crystal-controlled high-frequency fields. Mr. J. Guild (National Physical Laboratory) spoke on photometry. In the evening a large gathering at the Royal Astronomical Society's rooms in Burlington House received with enthusiasm a talk by Dr. M. A. Ellison on "New Tools for Solar Physics", which included a showing of Menzel's exciting film, "Explosions in the Sun". A parallel gathering in the Royal Photographic Society's rooms heard Mr. R. McV. Weston on the filming of living tissues with the microscope.

The morning of the concluding day, July 26, was occupied by three papers on spectrophotometry, the speakers being Prof. S. S. Ballard (United States), Dr. F. Devignes (France), and Dr. H. W. Thompson (Oxford). In the afternoon, talks on "The Modern Reflecting Telescope" and on a lens-mirror system for high-precision theodolites were given by Dr. E. H. Linfoot and by Dr. W. Lotmar (Switzerland), respectively; the Astronomer Royal was in the chair.

Most of the papers were followed by well-informed discussions, and a tendency to refrain from mutual criticism, noticeable at the early meetings, was corrected later on at the urgent request of the Conference's efficient secretary, Prof. L. C. Martin.

E. H. LINFOOT

INDUSTRY AND THE UNIVERSITIES IN GREAT BRITAIN

THE report of the Conference on Industry and the Universities, organised by the Education and Industrial Research Committees of the Federation of British Industries last November* and at which both industry and all the universities of Great Britain were represented, as well as the British Institute of Management and the Administrative Staff College, has now been published; it includes an analysis of the forty-three replies received to a twelve-point questionnaire previously sent out to individual industrialists regarding their experience in employing university graduates or reasons for being unable to make use of them. These replies, which covered positions in industry for which graduates are recruited, opportunities and prospects, periods of training after recruitment, qualities and characteristics sought by industry in its graduate recruits and comments on the current standard of graduates and the success of the universities in educating men for industry, were summarized and circulated to those attending the Conference and provided a basis for discussion.

Sir Hubert Henderson, opening the discussion on behalf of the universities, commented that the general

* Report of the Conference on Industry and the Universities, organised by the FBI Education and Industrial Research Committees and held at Ashorne Hill, Leamington Spa, 25 to 28 November 1949. Pp. 94. (London: Federation of British Industries, 1950.) 3s.

tone of the replies showed that there is already a much greater appreciation of the point of view of the universities than might have been found a short time ago. He endorsed Sir Charles Tennyson's observation that the prime function of the universities is to maintain and advance the standards of knowledge, and said that scholarship and research must be their dominant objectives: even the essential function of teaching would suffer if there were an attempt to subordinate the primary functions of maintaining and advancing the standard of knowledge to what was intended to be more efficient teaching. Sir Hubert thought, too, that the distinction between fundamental and applied knowledge can be overstressed; he knew of nothing more important in the history of the development of human thought than the advances which have been made by a constant interplay between abstract analysis and the attempts to solve particular concrete problems. Nevertheless, he agreed that things that are in the nature of techniques cannot profitably be taught in a university.

The report of the Conference includes brief summary reports from the discussion groups, which considered postgraduate studies and research, education for management, the supply of science teachers for schools, the interpretation of industry within the universities, and the development of closer relationships between industry and the universities. There was also some general discussion on the first three of these subjects, and the general feeling of the Conference was in favour of the Federation of British Industries doing what it can to see that the seriousness of the position regarding science masters is fully realized by the proper authorities. There was a decided cleavage of opinion as to whether management studies are appropriate for a university, most industrialists remaining neutral; but the Conference was agreed as to the desirability of not labelling courses so as to suggest that they represent the one and only approach to management.

At the third session, which considered industry's requirements of scientific workers and technologists and their education and training, Sir Arthur Fleming said that he preferred to absorb the graduate when he had gained his first degree; but urged the importance of giving the graduate the greatest possible amount of responsibility when he enters industry. Sir Arthur advocated at least two years training in works departments for the technologist. Wing-Commander T. R. Cave-Browne-Cave stressed the importance of personal qualities and of realistic personal touch between industry and universities. Prof. P. M. S. Blackett doubted the value of management courses and of vacation work; vacations offer invaluable opportunities of building character in other ways, and he pointed out that the universities can claim that, whether or not they produce the best men, a large and increasing proportion of the best of the youth of the country goes to the university and, when there, wishes to study a large variety of subjects.

Lord Simon of Wythenshawe presided over the fourth session, which dealt with industry's requirements of arts graduates, and the discussion was opened by Sir Humphrey Gale, who put, first, character, personality and power of leadership and, next, ability to write and speak clearly and to express succinctly the essentials of any given situation. Selection of arts graduates by industry requires more exacting methods than the selection of technologists, and he thought that appropriate use of such graduates might relieve technologists of marginal administrative work and reduce requirements of technologists. Lord Eustace Percy stressed the importance of the problem and the need not only to experiment with selection methods but also for the universities themselves to experiment both with different methods of teaching in the older established arts courses and with newer arts courses. Miss Marjorie Hayward said that she was encouraged by the importance attached to personal qualities but referred to the difficulties of placing arts graduates in industry. It was clear that this problem caused some concern to the Conference, and that it would be difficult to place the increased number of arts graduates of average ability unless industry could arrange training and apprenticeship schemes for them.

At the fifth session, Dr. Percy Dunsheath, Mr. C. Morris and Dr. A. E. Trueman attempted to summarize the preceding discussions and conclusions. The first two appealed for the fullest possible understanding between industry and the universities on all the important matters raised, and Dr. Trueman referred to the investigations into the supply and demand of scientific workers and technologists being undertaken by the Hankey Committee for the Ministry of Labour and the necessity of avoiding any steps likely to produce heavy graduate unemployment or misemployment. He urged that the universities should not be pressed to expand further, until they have had time to provide accommodation for the present increased numbers.

Particular points calling for action, which emerged at the Conference, were that a much greater supply of information by industry on its structure and its requirements of graduates should be made available to the universities and schools, and that industrialists should be encouraged to take a greater interest in the universities through their governing bodies, advisory councils and appointments boards, and, conversely, that university staffs should become better acquainted with industry. In regard to the first, information about careers in the various branches of industry and in individual firms is needed, and it was suggested that the Federation of British Industries could help by supplying such information. The interpretation of industry to the universities could be improved by temporary exchanges of industrial and university research staffs on an individual basis, and industry might further help by arranging short refresher and background courses for university professors and lecturers. The value of vacation courses was fully recognized, for arts students as well as for scientific workers and technologists, but not to the exclusion of other vacation activities. Increased flexibility in the postgraduate courses offered by the universities was suggested; and it was also proposed that the Federation of British Industries, in conjunction with the University Grants Committee, should organise a small team under the auspices of the Anglo-American Productivity Council to visit the United States for studying the relationship between American universities and industry, in order to see whether, and, if so, to what extent, this relationship is connected with the high productivity of American industry. Although the Conference considered that the shortage of science graduates would persist for several years, whether the position would thereafter improve remains uncertain, and industry should examine further the possibility of effecting economies in its use of science graduates.

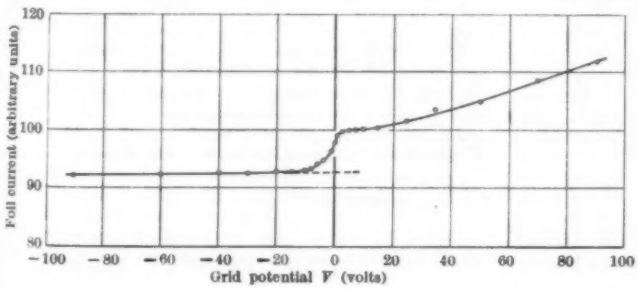
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Absolute Method for Measuring the Activity of Radioactive Isotopes

RADIOACTIVE isotopes are, at the present time, being used in a wide variety of scientific investigations. Thus the development of accurate methods for the assay of these substances is of considerable importance. The three methods in common use involve the Geiger counter, the ionization chamber and the micro-calorimeter; and, although simple in principle, they are quite complicated in practice. It therefore seemed worth while to investigate the possibilities of a new method based on the fact that a flow of β-particles is equivalent to a current. In the case of a pure β-emitting isotope, $3{\cdot}7 \times 10^7$ β-particles are emitted per second per millicurie (by definition), and this is equivalent to a current of $5{\cdot}93 \times 10^{-12}$ amp. If the isotope is deposited on a thin foil, mounted in a vacuum to eliminate gas ionization, and an electric field is applied to prevent slow secondary electrons from escaping, then the current flowing from the foil should be a direct measure of the total activity. The accurate measurement of a current in the region of 10^{-12} amp. is quite feasible, so that in principle it should be possible to measure radioactivity in this way. A preliminary investigation of the method has been completed, and the present communication gives a brief account of the results so far obtained, with particular reference to the effects caused by secondary emission and by ionization of the residual gas.

About 1 millicurie of phosphorus-32, deposited on a 0·0005-in. aluminium foil, was used in the experiment. The foil was completely surrounded by an open-mesh wire grid, which in turn was contained in an earthed metal box evacuated to a pressure of about 5×10^{-5} mm. mercury. The foil was supported by means of a light wire frame and remained within a few millivolts of earth potential, the current flowing from it being measured with the usual arrangement of high resistance, electrometer valve, and backing-off voltage. By applying a variable potential to the grid, it was possible to investigate the effect of secondary electrons produced when the β-particles emerged from the foil and when they reached the inside wall of the metal box. The results obtained are shown in the accompanying graph, where the positive current flowing from the foil to earth is plotted as a function of the potential (V) applied to the grid.



With a negative voltage applied to the grid, secondary electrons produced at the surface of the foil were repelled back to the foil, and those produced at the surface of the box were repelled back to the box. The shape of the curve between − 20 V. and + 5 V. is caused by the transition from a state in which no secondaries escaped to one in which all secondaries were collected by the grid, the intermediate value of current at $V = 0$ being due to the interception, by the foil, of some of the secondaries from the box. The curve shows that most of the secondaries were liberated with kinetic energies of only a few electron volts. At large negative values of V the curve has a slight slope which can be attributed to the repulsion of very slow β-particles. The intercept of the extrapolation of this part of the curve with the current axis at $V = 0$ gives the total number of β-particles produced per second.

The increased current observed at high positive values of V was caused by gas ionization. With positive values of V an electron, formed by ionization of the residual gas, would, in general, describe a very long oscillatory path before finally being collected by the grid. This follows from the facts that (*a*) such an electron could not reach either the foil or the box, because it starts at rest with too little potential energy, and that (*b*) it may pass through the grid many times before striking it, since the grid has a very open mesh. For values of V greater than the ionization potential of the residual gas, such electrons would cause further ionization, and the effect would be cumulative. In addition, the greater the value of V the greater would be the total ionization produced as a result of the formation of one primary electron. The curve is flat between $V = +4$ and $V = +12$ and then starts to rise, in agreement with the values of the ionization potentials of N_2, O_2 and H_2O (15·5, 12·5 and 12·6 volts, respectively). Furthermore, the slope of the curve in the region V greater than + 12 was found to increase approximately linearly with increasing gas pressure, whereas the rest of the curve was not affected.

These results show that the number of secondary electrons produced was small (about 7 per cent of the number of β-particles) and that most of them emerged with very little kinetic energy. These facts suggest that the method could be developed to give good absolute accuracy. In the present series of experiments no attempt was made to obtain good absolute accuracy, as the main purpose was the investigation of the possibilities of the method. The actual value found for the activity of the sample used was 0·82 millicurie, compared with the value 0·91 millicurie quoted by the Atomic Energy Research Establishment, Harwell.

An attempt is now being made to improve the accuracy of the method. This requires the application of corrections (*a*) for the absorption of β-particles by the foil and its supporting structure, and (*b*) for the emission of secondary electrons by the grid. Both these corrections can be made small, by means of suitable experimental conditions. In addition, it is necessary to measure a current of about 10^{-12} amp. with an accuracy of about ± 2 per cent, and a suitable method is being developed.

Measurements of other radioactive isotopes are also planned. In the case of ($\beta+\gamma$)-emitters, the measured current would include fast electrons produced by internal conversion, and a knowledge of the internal conversion coefficient would then be required before the activity of the source could be determined.

Since this work was started, Gross and Failla[1] have described experiments along similar lines, in which a magnetic field was used to prevent the escape of secondary electrons.

J. P. KEENE

Christie Hospital and Holt Radium Institute,
Withington, Manchester 20.
July 12.

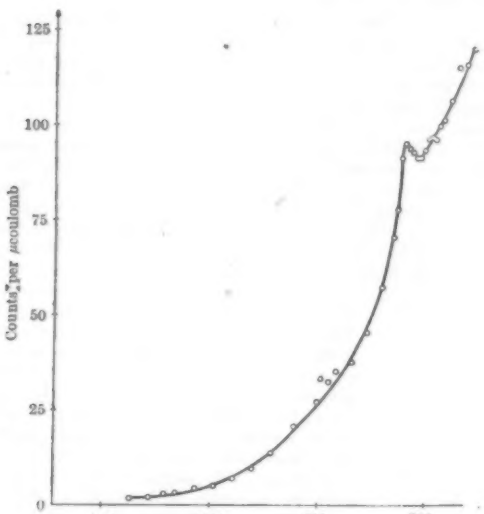
[1] Gross, W., and Failla, G., *Bull. Amer. Phys. Soc.*, **25**, No. 3, 18 (1950).

Thin-Target Yield of $O^{18}(p,\alpha)N^{15}$

THIN targets of oxygen-18, prepared by bombarding silver plates in an electromagnetic isotope separator at mass number 20 with water vapour in the ion source, were bombarded with protons (400–750 keV.) in a Cockcroft–Walton accelerator. The thin-target yield of α-particles within a cone of top angle 17° at 90° to the incident beam was studied with a proportional counter, the window thickness of which was such that only α-particles of range greater than 1·5 cm. in air could be detected. Gamma-rays had no influence upon the counter. The measured yield curve is given in the accompanying graph.

Five hours of proton bombardment did not change the yield beyond the limits of experimental accuracy. Range measurements showed that the energy of the α-particles corresponded to the Q-value of the reaction $O^{18}(p,\alpha)N^{15}$ reported in the literature[1,2].

As the yield curve shows a resonance at about 689 keV., the range of the α-particles at resonant proton energy was specially studied to make sure that the resonance did belong to the $O^{18}(p,\alpha)N^{15}$ reaction. The small irregularity at 600 keV. will be further investigated.



Thin-target yield curve for $O^{18}(p,\alpha)N^{15}$ at 90°

The voltage scale was calibrated at one point, 446 keV., with the $Li^7(p,\gamma)$ reaction on a separated lithium-7 target.

We wish to express our thanks to Messrs. S. Thulin and I. Bergström for preparing the targets in the isotope separator.

C. MILEIKOWSKY
R. T. PAULI

Nobel Institute for Physics,
Stockholm 50.
July 5.

[1] Burcham, W. E., and Smith, C. L., *Nature*, **143**, 795 (1939).
[2] Freeman, J. M., *Proc. Phys. Soc.*, A, **63**, 668 (1950).

Photo-oxidation of Water by Ceric Ions

IN view of the importance which is attached to the photochemical oxidation of water in the understanding of the process of photosynthesis[1], we would like to submit a scheme, which, as we show, agrees well with the data reported in the literature and our own experience in this field of research. Weiss and Porret[2] were the first to investigate the photo-oxidation by ceric ions (a qualitative observation to this effect had been made by Baur[3] in 1908). A more detailed study was carried out by Heidt and Smith[4]. The latter assumed the formation of an active ceric dimer being deactivated by cerous ions to account for their otherwise inexplicable observations as to dependence of the quantum yield on the concentration of ceric and cerous ions in solution. Spectrophotometric measurements carried out by us (to be published later) show conclusively that there is no dimer formation, and that in ceric perchlorate solutions in normal perchloric acid approximately 92 per cent of the ceric ion is present as the ion-pair complex $Ce^{4+}OH^-$. On the other hand, Heidt and Smith's kinetic results can be accounted for qualitatively and quantitatively on the basis of the following reaction scheme, which makes it also possible to explain in quantitative terms why in the case of ferric ions the quantum yield should be much smaller, and therefore under normal laboratory conditions scarcely measurable; as in our work on photo-initiated polymerization[5,6] and oxidation[7], we consider the primary step as an electron-transfer excitation with the ion-pair complex as the active species. This is the scheme we suggest:

$$(1)\quad Ce^{4+}OH^- \underset{k_d}{\overset{k_s I}{\rightleftharpoons}} Ce^{3+}OH.$$

$$(2)\quad Ce^{3+}OH \xrightarrow{k_s} Ce^{3+} + OH.$$

$$(3)\quad Ce^{3+} + OH \xrightarrow{k_6} Ce^{4+} + OH^-.$$

$$(4)\quad Ce^{4+}OH^- + OH \xrightarrow{k_1} Ce^{3+} + H_2O_2$$
(OH radical a reducing species!)

$$(5)\quad 2Ce^{4+}OH^- + H_2O_2 \longrightarrow 2HOH + 2Ce^{3+} + O_2\uparrow$$
not rate-determining

From stationary-state kinetics we obtain:

$$[Ce^{3+}OH] = \frac{k_s I}{k_d + k_s}$$

$$[OH] = \frac{k_s k_s I}{(k_d + k_s)\,(k_6[Ce^{3+}] + k_1\,[Ce^{4+}OH^-])}.$$

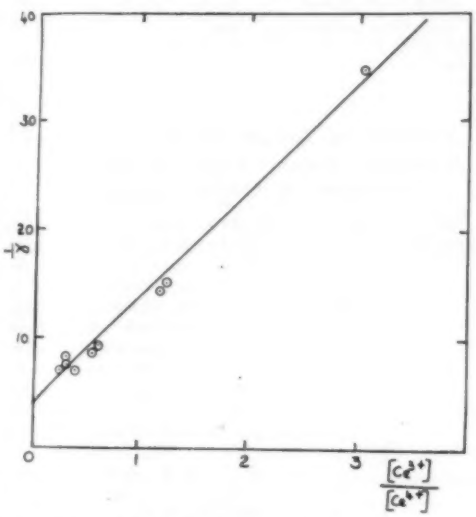
The net quantum yield with regard to Ce^{4+}-ion formation is:

$$\gamma_{net} = \frac{d[Ce^{3+}]}{dt} k_s I = \frac{4k_s}{k_d + k_s} \times \frac{k_1[Ce^{4+}\,OH^-]}{k_0[Ce^{3+}] + k_1[Ce^{4+}\,OH^-]}.$$

The maximum quantum yield is $4k_s/(k_d + k_s)$. The experimental observations would lead to a value of $\sim 5 \times 10^{-2}$ for $k_s/(k_d + k_s)$, that is, of a similar order to that observed for $Fe^{3+}OH^-$. It is obvious that

$$\frac{dO_2}{dt} = \frac{1}{4} \frac{dCe^{3+}}{dt}.$$

When the results obtained by Heidt and Smith are utilized for a plot of $1/\gamma$ against the ratio $[Ce^{3+}]/[Ce^{4+}]$, a straight line is obtained leading to values of $\sim 5 \times 10^{-2}$ for $k_s/(k_d + k_s)$ and 10 for k_0/k_1. This is shown in the accompanying graph. Heidt and Smith (*loc. cit.*) plotted instead the quantum yield against $[Ce^{4+}]/[Ce^{3+}]$ and obtained a hyperbola. It must be understood that, at very low ceric ion concentrations (less than $\sim 2 \times 10^{-3}\,M$), hydroxyl radicals would react with impurities in the distilled water. Under these conditions the maximum quantum yield will be $k_s/(k_d + k_s) \simeq 5 \times 10^{-2}$.



We note that both reactions (3) and (4) are considerably exothermic. The ionization potential of cerous ion in aqueous solution may be estimated as ~110 k.cal. (from the oxidation-reduction potential and the expected entropy change). With the values obtained by Evans and Uri[9], the heat of the reaction $Ce^{3+} + OH \rightarrow Ce^{4+} + OH^-$ and $Ce^{4+}OH^- + OH \rightarrow Ce^{3+} + H_2O_2$ may be calculated as ~25 k.cal. and ~20 k.cal. respectively. The experimental observations show that the respective rate constants differ at the most by one power of 10; which in energy terms means a difference as small as 1·5 k.cal. in the activation energy, assuming similar temperature-independent factors (which considerations of the entropy of activation would not make unlikely).

We would expect that this action of hydroxyl radicals which we discuss above will be found to be important in many reaction systems in aqueous solution. The relative rates of

$$Fe^{2+}OH^- + OH \rightarrow Fe^{3+} + H_2O_2$$
$$\text{and } Fe^{2+} + OH \rightarrow Fe^{3+} + OH^-$$

may well account for the high light-intensities required for the measurement of oxygen evolution from water and $Fe^{3+}OH^-$ complex.

M. G. Evans
N. Uri

Department of Chemistry,
University of Manchester,
Manchester 13.
July 11.

[1] Rabinowitch, "Photosynthesis", 1, 69 (New York and London: Interscience Publishers, 1945).
[2] Weiss and Porret, *Nature*, **139**, 1019 (1937).
[3] Baur, *Z. phys. Chem.*, **65**, 683 (1908).
[4] Heidt and Smith, *J. Amer. Chem. Soc.*, **70**, 2476 (1948).
[5] Evans and Uri, *Nature*, **164**, 404 (1949).
[6] Evans and Uri, *J. Soc. Dyers and Colour.*, **65**, 709 (1949).
[7] Bates, Evans and Uri (in the course of publication).
[8] Evans and Uri, *Trans. Farad. Soc.*, **45**, 224 (1949).

Photochemical Conversion of Stilbene to Phenanthrene

Smakula[1] noticed that irradiation of solutions of *cis*-stilbene with ultra-violet light caused the formation of material different from *trans*-stilbene, and this observation was confirmed by Lewis, Magel and Lipkin[2]. To our knowledge, the nature of this photochemical reaction has never been elucidated, nor have any products been identified.

We have succeeded in isolating a single product in good yield from cyclohexane solutions of *trans*-stilbene irradiated with ultra-violet light, and have unequivocally identified the product as phenanthrene.

Eventually we will present more extensive information concerning this reaction and its occurrence with *cis*-stilbene and α-phenylcinnamic acid.

Charles O. Parker
Paul E. Spoerri

Department of Chemistry,
Polytechnic Institute of Brooklyn.
June 9.

[1] Smakula, *Z. physik. Chem.*, B, **25**, 90 (1934).
[2] Lewis, Magel and Lipkin, *J. Amer. Chem. Soc.*, **62**, 2973 (1940).

Ferric Soaps as Catalysts for Vinyl Polymerization

In the course of work on the effect of metallic soaps on polymerization[1], we found ferric oleate to possess a fairly strong catalytic power for the polymerization of styrene and methyl methacrylate. As the problem presents some very unusual features, a detailed account of which will be published elsewhere, we report here some salient features about this new catalyst.

It might be suspected that some spurious peroxidic impurities likely to be present in the oleic acid were responsible for this catalytic property. This, however, was disproved by the following experiments. Ferric oleate solution in benzene was heated *in vacuo* at 80° C. for several days in order to decompose any peroxide present, and this pretreated solution was found to retain the power to catalyse the polymerization of styrene. Further, specially purified ferric laurate and ferric stearate were successfully used as catalysts in these polymerization experiments. Lastly,

oleic acid and stearic acid from which the soaps were prepared were found to have practically no effect on polymerization of styrene. Two typical experimental curves are shown in the accompanying graph.

Systematic experiments have been made to find the variation of the initial speed of polymerization of styrene with the concentrations of monomer and catalysts, and the results show that the initial velocity depends roughly on a power of monomer concentration lying between 3 and 4. The velocity of polymerization rose rapidly with increase in catalyst concentration; but no simple relation between them could be found.

The dependence of the degree of polymerization on the above factors was investigated. It has been found that it is inversely proportional to the square root of the catalyst concentration as in free-radical polymerization, but varied unexpectedly with the reciprocal of the monomer concentration. This last effect, that at the same catalyst concentration dilute solutions of monomer produce a higher degree of polymerization of the polymer, is very difficult to explain and distinguishes this catalyst from all other hitherto known types of catalysts. The accompanying table illustrates this point for styrene polymerization in benzene solution at 45° C. catalysed by ferric laurate ($2{\cdot}16 \times 10^{-3}$ moles per litre).

It is also observed that the catalytic power relative to the uncatalysed thermal reaction under the same experimental conditions is more prominent the lower the temperature, which probably indicates a lower energy of activation for the catalysed reaction. An idea of the relative rates at 35° and 60·4° C. can be obtained from the accompanying graph.

Though the above features are in sharp contrast to the free radical type polymerization, we have, however, verified that the ferric oleate catalysed polymerization of methyl methacrylate is susceptible to inhibition by benzoquinone, a feature generally considered to be characteristic of free radical polymerization. Further, no reduction of the ferric soap is involved, as the system fails to give a positive test for ferrous iron at the end of the polymerization run.

Monomer concentration [M]		[η]	Degree of polymerization (D.P.)*	D.P. × [M]
(Bulk)	8·64 molar	1·85	6,300	$54{\cdot}4 \times 10^3$
(Benzene soln.)	6·48 molar	2·23	8,140	$52{\cdot}7 \times 10^3$
,,	4·32 molar	3·25	13,770	$59{\cdot}5 \times 10^3$

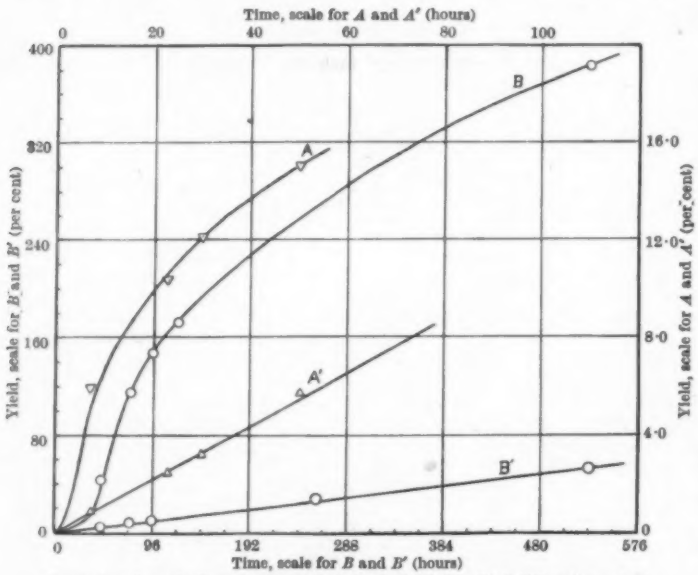
*Calculated from equation[2] $[\eta] = KM^{\alpha}$, $K = 1{\cdot}2 \times 10^{-4}$, $\alpha = 0{\cdot}72$

These results, which are fairly reproducible, are difficult to reconcile with a polar mechanism[3], as it is known that even strong Friedel–Crafts catalysts fail to initiate polymerization of methyl methacrylate[4]. Hence the question of classification of this type of catalyst into any of the two conventional types must remain open pending further investigation.

JYOTIBINDRA NATH SEN
SANTI R. PALIT

Indian Association for the
Cultivation of Science,
Calcutta 12.
May 18.

[1] Sen, J. N., Sengupta, R., and Palit, S. R., *J. Ind. Chem. Soc.*, **26**, 385 (1949).
[2] D'Alelio, G. F., "Experimental Plastics and Synthetic Resins", 71 (John Wiley and Sons, Inc., 1946).
[3] Heiligmann, R. G., *J. Polymer Sci.*, **4**, 183 (1949).
[4] Mayo, F. R., and Lewis, F. M., *J. Amer. Chem. Soc.*, **66**, 1594 (1944).



Curve *A*, polymerization of styrene in bulk at 60·4° C. with 0·025 mole per cent ferric stearate as catalyst; *A'* is same as *A* without catalyst. Curve *B*, polymerization of styrene in bulk at 35° C. with 0·026 mole per cent ferric oleate as catalyst; *B'* is same as *B* without catalyst

Removal of Girard Reagent 'T' from Biological Ketonic Fractions not easily Extracted by Organic Solvents

THE isolation of the ketonic fraction of biological materials by the use of trimethylcarbohydrazidomethylammonium chloride (reagent 'T') has been described by Girard and Sandulesco[1]. Essentially, the method utilizes the formation of water-soluble, ether-insoluble hydrazones between the ketonic bodies and the reagent, from which the non-ketonic fraction is removed by repeated ether extraction. This complex compound is then decomposed by treatment with mineral acid, and the resulting ketonic fraction extracted with ether.

The method is most satisfactory so long as the ketonic bodies are reasonably extractable by ether or another organic solvent immiscible with water. However, the study of the ketonic fractions from certain urinary and adrenal extracts in this Laboratory has shown that portion to be very readily soluble in water or alcoholic solvents, and not very easily recoverable by extraction with ether, chloroform, benzene, ethyl acetate, etc. Consequently, in order to prevent toxicity and interference by Girard reagent 'T' in the bio-assay of these

extracts for their power to inhibit the growth of *S37* transplants and induced tumours in mice and rats, the following method has been devised to remove the compound.

The aqueous solution remaining after removal of the non-ketonic fraction, by repeated extraction with various solvents, is acidified to 0·5–1·0 *N* with hydrochloric or sulphuric acid, thereby decomposing the ketone-reagent 'T' hydrazones on standing or with gentle warming. To this aqueous solution is added approximately 2–3 times its volume of absolute methanol, followed by approximately 15–20 times its volume or more of ether. The minimum volume of methanol is added in order to ensure a one-phase system, and the maximum amount of ether without separation into two layers. Under these conditions, the Girard reagent 'T' is precipitated on standing and may be filtered off; any material remaining on the precipitate may be washed off by cold methanol, and filtered into a good volume of ether, when the small quantity of reagent 'T' dissolved by the methanol is precipitated, while the ketonic bodies present in small concentration are sufficiently soluble in the large volume of the methanol/ether mixture.

The total ether/methanol/water solution may then be concentrated under reduced pressure to a suitable residue, when the process may be repeated if necessary until most, if not all, of the Girard reagent 'T' is removed.

This separation has been found to be very useful in dealing with the small quantities of total solids from urinary and adrenal extracts, particularly as a comparatively large amount of reagent 'T' is recommended for a good separation of the ketonic bodies. By this method, for example, these extremely water-soluble ketonic fractions, extractable by ether with very great difficulty, can be bio-assayed without interference from the separating reagent, and it is hoped that it may be equally of value to workers of other fields who use this very convenient fractionation.

C. L. WALTERS

Hosa Research Laboratories,
Sunbury-on-Thames,
Middlesex.
June 6.

[1] Girard and Sandulesco, *Helv. Chem. Acta*, **19**, 1095 (1936).

Possible *f*-Shell Covalency in the Actinide Elements

UNDER the above title, Glueckauf and McKay[1] have presented a discussion, based in part on data of Katzin and Sullivan[2], in which they suggest that the co-ordination of nitrate groups, and the extraction of uranyl, neptunyl and plutonyl nitrates into organic solvents, are phenomena different in kind from those found with elements lower in the periodic table, and are therefore indicative of possible *f*-shell covalency. I believe that the co-ordination of nitrate by uranyl ion is neither unique nor different in kind from that found lower in the Periodic Table, and in particular with a transition element such as cobalt.

Katzin and Gebert[3] have shown that cobaltous nitrate, dissolved in an organic solvent such as acetone or tertiary butyl alcohol, is undissociated, and probably conforms to the formula $Co(NO_3)_2.4X$, where X represents a solvent group. Furthermore, the presence of nitrate ion in the solution results in formation of a trinitrato-cobalt (II) complex. Ternary phase studies, similar to those by Katzin and Sullivan[2] on the uranyl nitrate – water – solvent system, have been made on the systems cobalt nitrate – water – acetone and cobalt nitrate – water – tertiary butyl alcohol by Katzin and Ferraro[4]. These have demonstrated that the behaviour of cobalt nitrate in these systems is essentially like that found for uranyl nitrate. Spectrophotometric data on the changes induced in the light absorption of the nitrate group by various metal ions in tertiary butyl alcohol solution[5] show that manganous, cobaltous, nickelous and cupric nitrates exhibit striking and characteristic modifications of the nitrate group absorption, which can be traced to formation of the undissociated salt. In addition, further investigation of cupric nitrate[6] shows formation of trinitrato complex in acetone solution. Although the effects on the spectrum were not as marked as for the salts with incomplete *d*-shells, lithium, magnesium, calcium, aluminum, zinc, cadmium and thorium nitrates, as well as nitric acid, in tertiary butyl alcohol solution, showed modifications of the nitrate ion absorption from that in water[5]. Von Halban[7] and co-workers have studied the nitric acid case in detail, showing the change to be due to formation of undissociated unhydrated HNO_3, and there seems justification for assuming that all the spectral alterations noted reflect formation of undissociated molecules. Even in aqueous solution, the alkaline earth nitrates give evidence of partial association[8].

In summary, then, rather than perceiving unique properties, one is struck by the similarity of behaviour of uranyl nitrate and the simple divalent metal nitrates, in particular, those of the transition elements. Furthermore, there is no evidence in any of our data for true covalency; all the complexes formed are by all criteria of the 'ionic' type. The behaviour in organic solution, common to uranyl nitrate and nitrates of the divalent transition elements lower in the periodic table, has led me to a generalized picture of the solution processes of salts in electron-donor solvents, including water, which it is hoped to present in detail at another time.

LEONARD I. KATZIN

Argonne National Laboratory,
Chicago 80, Illinois.

[1] Glueckauf, E., and McKay, H. A. C., *Nature*, **165**, 594 (1950).
[2] Katzin, L. I., and Sullivan, J. C., Atomic Energy Commission Document No. 2537; *J. Phys. Coll. Chem.* (in the press).
[3] Katzin, L. I., and Gebert, E., *J. Amer. Chem. Soc.* (in the press).
[4] Katzin, L. I., and Ferraro, J. R., *J. Amer. Chem. Soc.* (in the press).
[5] Katzin, L. I., *J. Chem. Physics*, **18**, 789 (1950).
[6] Katzin, L. I., and Gebert, E. (unpublished work).
[7] von Halban, H., "Contrib. étude structure mol.", Vol. commém. Victor Henri, 239 (1947/48).
[8] Robinson, R. A., Wilson, J. M., and Ayling, H. S., *J. Amer. Chem. Soc.*, **64**, 1469 (1942). Harned, H. S., and Owen, B. B., "Physical Chemistry of Electrolytic Solutions", 423 (Reinhold Pub. Co., New York, 1943). Hagemann, F. (personal communication re radium nitrate).

DR. KATZIN bases his argument chiefly on certain similarities in the behaviour of uranyl nitrate and the divalent transition metal nitrates in acetone and tertiary butyl alcohol. In ethers, however, the differences in solubility are extraordinarily large, and this forms one of our main pieces of evidence. It implies that the free energy of transference from water to ether is some 10 k.cal./mol. greater for uranyl than for, say, cobalt nitrate.

Such a high energy suggests that undissociated uranyl nitrate, perhaps unlike most other nitrates, may exist in covalent rather than ion-pair form. Indeed, the mere fact that the properties in question are most highly developed for the very large uranyl ion would seem to rule out any explanation in terms of ion-pairs alone.

As the title of our note made clear, we consider *f*-shell covalency a possibility rather than a certainty, and we hope that further evidence will be forthcoming from other lines of approach. For the present, the conclusion reached will depend on the relative weight given to different lines of argument, and in spite of Katzin's comments we still favour our original suggestion.

E. Glueckauf
H. A. C. McKay

Atomic Energy Research Establishment,
Harwell, Berks.

Mode of Action of Specific Solvents for Bituminous Coals

It has been reported[1] that conditions of solution such as coal/solvent ratio and successive treatment with solvent have a considerable influence on the yield of extract obtained when coals of low rank are treated with specific solvents[2]. Further work has shown that these effects, and others since observed, can largely be ascribed to mechanical causes, and they will therefore not be discussed in detail. Four points of interest have, however, come to light.

(1) Mechanical shaking, although desirable in order to increase the *rate* of solution, has a markedly adverse effect on the yield of soluble material which can be obtained in a single treatment.

(2) By appropriate methods a maximum yield of soluble matter can be obtained, which depends only upon the type of coal, the solvent and the temperature of treatment. This limiting yield may be reached by extended treatment (successive extraction) in spite of the adverse effect of shaking mentioned in note (1).

(3) With the lowest-rank coals (the internal colloidal structure of which is readily accessible to liquids), and one or two of the best solvents, the concentration of dissolved material appears to be the same both in the solvent imbibed into the micropores and in the bulk solution outside the coal particles. This, however, is only strictly true under ideal conditions of mechanical treatment. It is considered to represent the fundamental primary equilibrium.

(4) An important departure from the behaviour described in note (3) is observed when the bulk solution concentration exceeds a certain value, for example, approximately 8 gm./100 c.c. in the case of ethylene diamine; the concentration in the bulk solution then appears to increase at the expense of that in the micropores, and in consequence the recoverable extract or apparent yield increases. This effect is ascribed to aggregation of the soluble units in the bulk solution. Evidence of such aggregation is shown independently by the tendency of strong solutions rapidly to form surface skins and to throw down sludge, whereas dilute solutions are stable almost indefinitely.

The function of the solvent in reversing the effect of ageing has already been pointed out[2]. If imbibed solvent can loosen up the colloidal structure of the solid sufficiently, it is probable that controlling factors more akin to equilibrium solubility come into play. Up to a volume imbibition ratio of approximately 2, whether the (specific) solvent or the coal is varied, extraction yield shows a striking proportionality to the imbibition ratio. But the greater the imbibition the greater become the differences between the yields obtained with different solvents at a given swelling-level; scatter increases, and a departure from the average linear proportionality is also observed at very high imbibition ratios. In this upper range, it is probable (and supported by independent evidence) that the yield of extract is determined chiefly by the size distribution of colloidal units in the coal in relation to the largest unit which is appreciably soluble (in the equilibrium sense); in the lower range, on the contrary, a large measure of control must be exerted by difficulties of disengagement, that is, by what may be termed a micellar sieve mechanism.

The temperature coefficient of extraction yield varies to a limited extent with the rank of coal. The property found most suitable for characterizing rank in this connexion is the amount of solvent imbibed at room temperature. When the volume imbibition ratio exceeds unity, the value of the temperature coefficient ceases to change further with rank. This observation is probably to be explained in terms of a coefficient fundamentally independent of rank but nevertheless influenced by a barrier to solution imposed by the sieve mechanism mentioned in the previous paragraph. It is probable that the constant value of the temperature coefficient can be used, on the lines indicated by Brønsted[3], Schulz[4] and Gee[5], to deduce a size distribution for the unit particles of soluble material. The form of the relation between extraction yield (in ethylene diamine) and temperature, for a number of coals with which the imbibition ratio exceeds unity, indicates, if interpreted in this way, a modal size which is constant over a considerable range of rank; but in the present state of knowledge it is impossible to calculate the absolute magnitude of this parameter. The value of the modal size is of interest in connexion with estimates of the average colloidal unit size derived from porosity and heat of wetting (internal surface) measurements by Bangham[6] and co-workers, of crystallite sizes derived by Riley[7] and co-workers, and of molecular weights determined by cryoscopic methods[8].

A fuller account of this work will be published elsewhere.

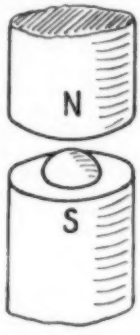
I. G. C. Dryden

British Coal Utilisation
Research Association,
Randalls Road,
Leatherhead,
Surrey.
June 8.

[1] Dryden, I. G. C., *Nature*, **162**, 959 (1948); **163**, 141 (1949).
[2] [*Nature*, **166**, 561 (1950).]
[3] Brønsted, J. N., *C. R. Lab. Carlsberg*, Sér. chim., **22**, 99 (1938).
[4] Schulz, G. V., *Z. phys. Chem.*, A, **179**, 321 (1937).
[5] Gee, G., Ann. Rep. Chem. Soc., **39**, 7 (1942).
[6] Bangham, D. H., Franklin, R. E., Hirst, W., and Maggs, F. A. P., *Fuel*, **28**, 231 (1949).
[7] Blayden, H. E., Gibson, J., and Riley, H. L., "The Ultrafine Structure of Coals and Coke", 176 (Brit. Coal Util. Res. Assoc., 1944).
[8] For example, see: Asbury, R. S., *Indust. Eng. Chem.*, **28**, 687 (1936). Kuznetzov, M. I., *Khim. Tver. Topl.*, **6**, 515 (1935); *Fuel*, **16**, 114 (1937). Biggs, B. S., *J. Amer. Chem. Soc.*, **58**, 484, 1020 (1936).

Use of a Magnetic Field in Detecting Corrosion Currents

When a drop of dilute potassium chloride solution is placed on a horizontal sheet of freshly abraded iron, corrosion occurs at the centre of the drop, but the periphery remains unattacked[1]. This phenomenon is commonly ascribed to electric currents flowing between the (well-aerated) peripheral zone as cathode and the (less well-aerated) central zone as anode. In several analogous cases, such as partly immersed plates of metal, the electric currents have been measured and found to be sufficiently strong to account for the whole of the corrosion observed[2]. The study of the currents flowing in drops has been somewhat less direct, and the following experiment may possess general interest.



A powerful electromagnet is provided with two iron pole-pieces, the air gap being a few millimetres across (see diagram). A drop of potassium chloride, or similar salt solution, placed on the lower surface, is found to rotate when the magnetic field is turned on; the direction of rotation changes from clockwise to counter-clockwise when the polarity of the field is reversed. The rotation is best observed by the use of dark-background illumination; the light (suitably filtered to eliminate heat rays) arrives from the left, and the observations are made from the front by means of a lens or microscope. The observation of the movement depends upon the presence of the small dust particles commonly present in water which has not been specially prepared.

From the velocity of rotation, a rough estimate of the strength of the current flowing can be obtained in the following way. A drop is placed in the gap of the magnet, in such a way that its centre rests on a small circular electrode and the periphery on a ring electrode of platinum wire. An E.M.F. is applied between the two electrodes and the current flowing is measured directly. The relation between current and rotation velocity can thus be obtained, and the results used for obtaining the strength of the current flowing in the main experiments.

In other experiments, arrangements were made for the replacement of air by nitrogen. This replacement caused the rotation of the drop to become very much slower—confirming the explanation given above.

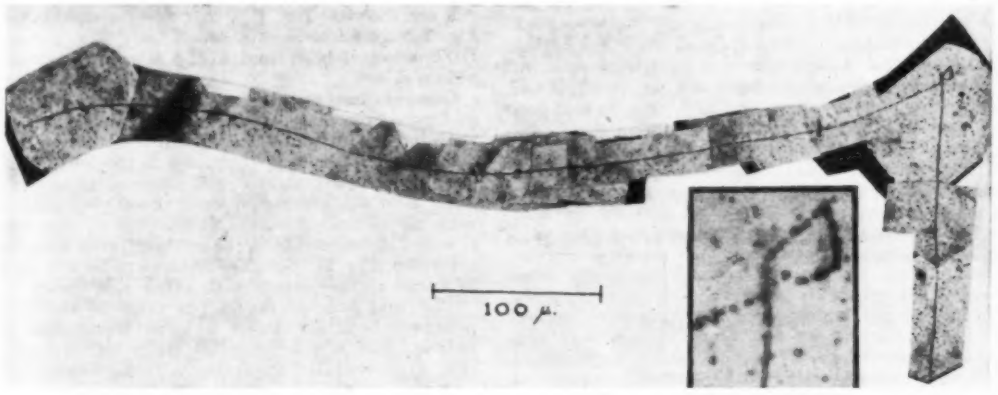
F. Blaha

Nussdorferstrasse 70,
Vienna 9.
March 8.

[1] Evans, U. R., *J. Soc. Chem. Indust. Trans.*, **43**, 315 (1924).
[2] Evans, U. R., and Hoar, T. P., *Proc. Roy. Soc.*, A, **137**, 343 (1932). Evans, U. R., and Agar, J. N., *J. Iron and Steel Inst.*, **141**, 221 P (1940).

An Unusual π—μ Decay Track

The accompanying photograph shows an event observed in an *N.T.*4 plate exposed for several hours at an altitude of some 90,000 ft. in balloon flights made recently at Bangalore. The heavier track enters the emulsion from the air, and gives rise to the lighter track after a path of 535 μ. The lighter track has a range of 571 μ and ends in the emulsion. The event can be identified with confidence as an example of π—μ decay. The grain densities are also consistent with this explanation.



A remarkable feature of the event, however, is the sequence of three large-angle scatterings near the end of the π-track. The μ-track originates at a distance of 2 μ from the third scattering, and passes slightly underneath the π-track, thus forming a closed loop. The inset photograph shows the loop on a larger scale. We have not previously observed the formation of a closed loop by scattering, and the event seems sufficiently curious to be worth recording.

D. Lal
H. J. Taylor

Tata Institute of Fundamental Research,
Bombay.
June 22.

Estimation of Heterogeneous Error Variances

We consider a set of pq observations x_{ij} in a two-way classification, which we may suppose represented by the model

$$x_{ij} = \alpha_i + \beta_j + \varepsilon_{ij} \quad (i = 1, 2, \ldots p\,;\; j = 1, 2, \ldots q),$$

where α_i and β_j are constants and the ε_{ij} are independent normal random errors with zero means and variances σ_j^2; α_i, β_j and σ_j^2 are unknown, and it is desired to estimate σ_j^2. The problem arises, for example, in investigating the accuracy of a food-tasting panel; α_i depends on the food-specimen tasted, β_j is the bias and σ_j^2 the residual error variance of the j^{th} panel member.

If p or q is small, the method of maximum likelihood does not give a satisfactory estimate of σ_j^2. Kendall[1] notes that when $q = 2$ the maximum likelihood estimates of σ_1^2 and σ_2^2 are equal, and therefore are not consistent if, in fact, σ_1^2 and σ_2^2 are unequal.

It is of interest to consider estimates which are, in the first place, unbiased. One such estimate, valid for $q \geqslant 3$, is

$$s_j^2 = \frac{q}{(p-1)(q-2)} \left\{ \sum_i^p (x_{ij} - x_{i.} - x_{.j} + x_{..})^2 - \frac{1}{q(q-1)} \sum_i^p \sum_r^q (x_{ir} - x_{i.} - x_{.r} + x_{..})^2 \right\},$$

where $x_{i.}$ and $x_{.j}$ denote partial means and $x_{..}$ the overall mean of x_{ij}. Another estimate, valid for $q \geqslant 2$, is

$$s_j'^2 = \frac{1}{p-1} \left\{ \sum_i (x_{ij} - x_{.j})^2 - \frac{2}{q(q-1)} \sum_i \sum_{r>s} (x_{ir} - x_{.r})(x_{is} - x_{.s}) \right\}.$$

When $q = 2$ this gives, for $j = 1$, say,

$$s_1'^2 = \frac{1}{p-1} \sum_i (x_{i1} - x_{.1})(x_{i1} - x_{.1} - x_{i2} + x_{.2}),$$

which can be shown to be the only unbiased quadratic-form estimate of σ_1^2.

The variances of these estimates of σ_j^2 depend on other unknowns besides σ_j^2 itself. We find

$$\text{var}\,(s_j^2) = \frac{2\sigma_j^4}{p-1} + \frac{4}{(p-1)(q-1)^2} \left\{ \sigma_j^2 \sum_{r \neq j} \sigma_r^2 + \frac{1}{(q-2)^2} \sum_{\substack{r>s \\ r,s \neq j}} \sigma_r^2 \sigma_s^2 \right\},$$

which depends on all of $\sigma_1^2, \sigma_2^2, \ldots \sigma_q^2$; and

$$\text{var}\,(s_j'^2) = \frac{2\sigma_j^4}{p-1} + \frac{p-2}{p(p-1)^2 q^2} \sum_i (\alpha_i - \alpha_.)^2 \left\{ (q-1)^2 \sigma_j^2 + \sum_{r \neq j} \sigma_r^2 \right\} + \frac{4}{(p-1)q^2(q-1)^2} \sum_{r>s} \sigma_r^2 \sigma_s^2,$$

which depends in addition on $\alpha_1, \alpha_2, \ldots \alpha_p$. When $q > 2$ and both estimates are available, sometimes one and sometimes the other has the lower variance, according to the values of the other parameters.

A full discussion is in preparation. The investigation is in connexion with work done on behalf of the Department of Scientific and Industrial Research (Food Investigation).

A. S. C. Ehrenberg

Statistical Laboratory,
University of Cambridge.
April 19.

[1] Kendall, M. G., *J. Roy. Statist. Soc.*, B (In the press).

Changes in the Histology of the Honey-bee Ventriculus Associated with the Ingestion of Certain Insecticides

Although the histological changes produced by insecticides have been the object of study by a few investigators[1], the subject has on the whole received little attention. Recently a comparative study of the histology of the honey-bee ventriculus, following the administration, in individual graded doses, of the insecticides, acid lead arsenate, DDT and 'Parathion', has been made. In addition, the median lethal doses for the insecticides were determined, and observations on the behaviour of the poisoned bees and the macroscopical appearance of the mid-guts (ventriculi) were made. For the microscopical studies material was prepared with only slight modifications of standard histological procedures. (The name 'Parathion' is used here for the compound *o,o*-diethyl *o,p*-nitrophenyl thiophosphate.)

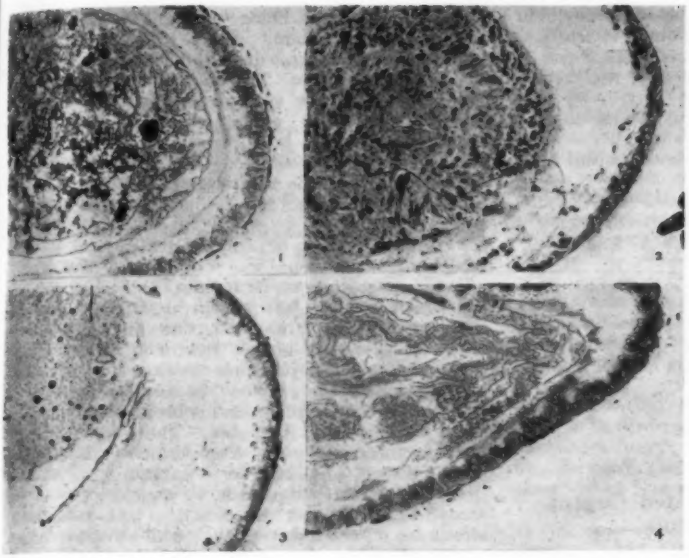
It was found that in some instances there were definite histological abnormalities following the administration of the insecticides. When present, these abnormalities were mostly confined to the middle region of the ventriculus. Photomicrographs of transverse sections through this region of the mid-gut are shown. Fig. 1 is that from a normal bee; Fig. 2 from an arsenic-poisoned bee; Fig. 3 from a DDT-poisoned bee; and Fig. 4 from a 'parathion'-poisoned bee.

Observations on the macroscopic appearance of mid-guts from arsenic-poisoned bees showed that all were lighter in colour than those from normal bees, and that 90 per cent contained a greyish plug-like mass near their posterior end. Microscopically, mid-guts from all arsenic-poisoned bees presented the same appearance: severe vacuolization, desquamation and degeneration of the epithelial cells were characteristic (Fig. 2). Similar effects have been observed in various experiments with other test insects[2,3].

The mid-guts of 50–60 per cent of the DDT-poisoned bees contained a large transparent gas bubble, and a microscopical study of this region (Fig. 3) showed that the epithelial lining was stretched and that increased proliferation, vacuolization and secretion from the epithelial cells were taking place. The epithelial lining of mid-guts containing no gas bubble was not stretched appreciably; but the condition and activity of the epithelial cells were similar. It is suggested that this activity of the epithelial cells is a result of the hyperactivity of the insect, caused by the action of DDT on the nervous system.

Both the macroscopic and the microscopic (Fig. 4) appearance of the mid-guts of 'Parathion'-poisoned bees closely resembled those of normal bees. The hyperactivity and characteristic circus movements of a 'Parathion'-poisoned bee indicated that this insecticide was acting as a nerve poison.

A fuller account of this investigation will be given elsewhere.



I wish to thank Mr. A. J. Musgrave (Ent.) for directing this work, and Mr. G. F. Townsend (Apic.) for advice and encouragement.

E. H. Salkeld

Departments of Entomology and Apiculture,
Ontario Agricultural College,
Guelph, Canada.
May 25.

[1] Metcalf, R. L., "The Mode of Action of Organic Insecticides", Review No. 1, National Research Council, Washington (1948).
[2] Parfentjev, J. A., Trans. IV Internat. Ent. Congr. (1928), 857–64.
[3] Pilat, M., *Bull. Ent. Res.*, **26**, 465 (1935).

Functions of Hæmoglobin in *Daphnia*

In well-aerated waters *Daphnia* is pale, whereas in waters deficient in dissolved oxygen it is pink or red. The depth of colour is proportional to the oxygen deficit[1,2]. The colour is due to hæmoglobin in the blood, and when the animals are transferred from well-aerated to poorly aerated water or *vice versa*, the resulting synthesis or loss of hæmoglobin is very considerable and remarkably rapid. In a week a pale population can become red. The phenomenon is comparable with the increase in the hæmoglobin content of the blood of human beings exposed to the lower oxygen pressure of a high altitude. This increase is functional and it might be expected that the increase in the respiratory pigment of *Daphnia* would also be of value to the animals.

In *Daphnia* not only blood but also the parthenogenetic eggs contain hæmoglobin[3]. The pigment passes from the blood into the ovary[4], and so in oxygen-deficient water the eggs, like the blood, contain extra hæmoglobin. It has been shown that the hæmoglobin in the eggs is of value to *Daphnia* in oxygen-deficient water: it increases the rate of development of the embryos[1]. We have now made extensive studies of the function of the respiratory pigment in the blood, and they are briefly reported below.

The first experiments were made to see whether red *Daphnia* survives longer than pale in oxygen-deficient water. Animals from the same stock were cultured in waters of low and high air content until they became red and pale respectively. Then twenty red individuals were put into a large stoppered bottle completely full of water with a low dissolved oxygen content, just above that at which oxyhæmoglobin can be seen to lose its oxygen in the blood of *Daphnia*[5]. The bottle was sufficiently large for the oxygen content of the water not to be reduced much by the animals during the experiment. Into a similar bottle twenty pale individuals were put. One by one the pale animals died, and when ten of them were dead it was found that all the red individuals were still alive. Several such experiments were made, with the same result, which shows that in poorly aerated water the hæmoglobin synthesized by *Daphnia* helps the animals to survive. Earlier experiments[1] had failed to demonstrate this, the reason probably being that they had not been continued long enough.

The animals in the above experiments received no food. We next tested whether hæmoglobin assists *Daphnia* to feed in water deficient in oxygen. *Daphnia* can clear turbid water by collecting and eating suspended particles; this is done just as much if the particles are inorganic as if they are nutritious algæ. We made use of this faculty and measured the decrease in density of suspensions of graphite caused by *Daphnia*. The changes in optical density of the suspension were measured with a photometer. Preliminary experiments showed that in waters containing less and less dissolved oxygen, progressively less graphite is cleared in unit time. It was next found that hæmoglobin intervenes: at each different low value of dissolved oxygen, red animals can clear more graphite than pale ones. This was confirmed by comparing the clearance by normal red *Daphnia* with that by animals treated with carbon monoxide to inactivate the hæmoglobin as an oxygen carrier: in oxygen-deficient water the normal animals cleared more graphite. Further confirmation was obtained by comparing the clearance, in waters of different oxygen content, of a food alga, *Chlorella*, by red and pale *Daphnia*, and also by animals with oxy- and carboxy-hæmoglobin. The results were the same as with graphite. In aerated water, however, hæmoglobin was found to give no advantage, and indeed in Nature it would have mostly vanished.

It was next found that in poorly aerated water *Daphnia* produces fewer and fewer parthenogenetic eggs in proportion to the oxygen deficit. We therefore made experiments to find out if hæmoglobin assists the egg production. It turned out that at each low value of dissolved oxygen more eggs were laid in the brood pouch by normal red animals than by others with carboxyhæmoglobin. It is known that in *Daphnia* the number of eggs depends upon the amount of food eaten, and the greater number of eggs produced in semi-anaerobic conditions thanks to hæmoglobin may well be due, at least in part, to the better nutrition resulting from the respiratory pigment.

It has thus been shown that the blood hæmoglobin synthesized by *Daphnia* in response to oxygen deficiency in the water has the following functions: it resists asphyxia, and it assists feeding and reproduction. The aid to reproduction is both by producing more eggs and by supplying hæmoglobin to the eggs and so accelerating development.

These results will soon be published in full elsewhere.

H. Munro Fox
Barbara M. Gilchrist
Elizabeth A. Phear

Zoology Department,
Bedford College,
University of London.
Aug. 24.

[1] Fox, H. Munro, *Proc. Roy. Soc.*, B, **135**, 195 (1948).
[2] Fox, H. Munro, Hardcastle, S. M., and Dresel, E. I. B., *Proc. Roy. Soc.*, B, **136**, 338 (1949).
[3] Teissier, G., *C.R. Soc. Biol., Paris*, **109**, 813 (1932).
[4] Dresel, E. I. B., *Nature*, **162**, 736 (1948).
[5] Fox, H. Munro, *J. Exp. Biol.*, **21**, 161 (1945).

Supersensitivity of Denervated Organs to Chemical Stimuli

The analysis of phenomena such as the 'pseudomotor reactions' or the 'paradoxical pupillary dilation' has revealed that structures deprived of their normal nerve supply show a supersensitivity to chemical stimuli. In 1939 Cannon formulated the law of denervation: "When in a series of efferent neurones a unit is destroyed, an increased irritability to chemical agents develops in the isolated structure or structures, the effect being maximal in the part directly denervated". In their recent monograph on "The Supersensitivity of Denervated Structures"[1], Cannon and Rosenblueth have discussed various factors which might be responsible for the sensitization of cells after degenerative section of their efferent nerve supply, such as inactivity, suppression of the release of chemical mediators, or removal of some kind of 'trophic' influence of nerves on the cells.

In our experiments we have, instead of excluding nerve impulses by severance of efferent nerves, attempted to make such impulses ineffective on the innervated structures. This can be achieved pharmacologically by treatment with drugs which render the effector cells insensitive to the chemical mediators of nerve impulses. The submaxillary gland of the cat affords a preparation well suited for experiments of this kind. Stimulation of the main secretory nerve of the gland, the chorda tympani, evokes an abundant flow of saliva; after administration of atropine, however, chorda stimulation has no secretory effect. Stimulation of the cervical sympathetic nerve, or intravenous injection of adrenaline, is likewise followed by salivary secretion. This effect is not antagonized by moderate doses of atropine. Some days after section of the chorda tympani, the gland is found to be supersensitive to adrenaline[2]; the threshold dose of adrenaline for the parasympathetically decentralized gland is much smaller than that for the normal gland, and a moderate dose of adrenaline gives a much greater response from the decentralized than from the normal salivary gland.

In a series of cats, atropine was injected subcutaneously twice daily over a period of 7–10 days. As pharmacological and clinical experience suggests that some kind of 'habituation' to atropine may occur, the doses of atropine given were increased successively, the first dose being 0·5 mgm./kgm., the last dose 10–15 mgm./kgm. Some 15–20 hr. after the injection of the biggest dose, the cats were anæsthetized with chloralose. The submaxillary ducts were cannulated, and the sialogogue effect of adrenaline was tested. The atropine-treated glands were invariably found to be supersensitive to adrenaline. The sensitization resembled that brought about by section of the chorda tympani. Thus, in a series of cats in which the chorda of one side had been cut aseptically at the beginning of the atropine treatment, the threshold dose of adrenaline, estimated after atropine pretreatment, was found to be of the same order of magnitude on both sides. A dose of adrenaline which evokes a just perceptible salivary secretion from a normally innervated, untreated gland was found to elicit an almost maximal response after atropine treatment, just as is the case after degenerative section of the chorda. It seems reasonable to assume that the sensitization is brought about in the same way in both instances. The main difference between the two types of sensitization is that section of the chorda abolishes nerve impulses (or at least denervates the submaxillary ganglion), whereas atropine antagonizes the action of the transmitter substance on the effector cells. The atropine experiments, therefore, may shed some light on the mechanism responsible for the sensitization of the gland to chemical agents.

An attempt was made to prevent the sensitization developing after severance of the chorda by daily injections of pilocarpine. Unfortunately, only one cat has so far survived the injection, twice a day, of 1 mgm. of pilocarpine per kgm. during eight days. In this animal the adrenaline sensitivity of the parasympathetically decentralized gland was found to be as low as that of a normally innervated gland.

The experiments described here do not support the theory that the normally innervated gland is subjected to a 'trophic' influence, the disappearance of which is followed by supersensitivity of the gland to chemical agents. Nor can the sensitization occur consequent on a suppression of the liberation of the transmitter substance. Changes in the cells, due to absence of chemical stimuli or to the inability of stimulating substances to attach themselves to certain receptors, may in some way be responsible for the supersensitivity to chemical agents which appears after section of the chorda or pretreatment with atropine.

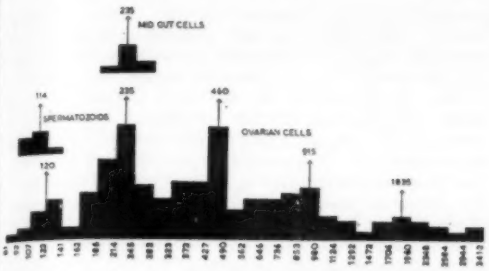
N. Emmelin
A. Muren

Physiological Institute,
University of Lund.
June 6.

[1] Cannon, W. B., and Rosenblueth, A., "The Supersensitivity of Denervated Structures" (New York and London: Macmillan, 1949).
[2] Fleming, A. J., and MacIntosh, F. C., *Quart. J. Exp. Physiol.*, **25**, 207 (1935).

Deoxyribonucleic Acid Content of Ovarian Cells in *Artemia salina*

In the ovary of *Artemia salina*, some oocytes undergo a peculiar transformation[1]. After the primary growth period, numerous granules giving a positive Feulgen reaction appear in the nucleus, fuse into clumps, and finally give rise to a large homogeneous droplet of strongly Feulgen-positive material. This droplet is expelled into the cytoplasm through a hole in the nuclear membrane. The nucleus remains as a clear vesicle containing nucleoli and ribonucleic



granules but devoid of deoxyribonucleic acid. Finally, the droplet is expelled from the cell and disappears entirely. This process appears to be very different from common pycnosis and caryorhexis. It is, so far as we know, the only case where deoxyribonucleic acid is expelled as a whole into the cytoplasm, while the other components of the nucleus remain apparently unchanged.

Since the constant character of the phenomenon consists in a great increase in the amount of the deoxyribonucleic acid in the nucleus, it was suggested that this peculiar kind of cell degeneration may be the sequel of successive waves of endopolyploidy.

This hypothesis has been tested by determining quantitatively the deoxyribonucleic acid *in situ* by means of histophotometrical measurements (see ref. 2 for details of the apparatus). The material used was fixed in alcohol-formalin (9/1) and sections examined by the Feulgen reaction. Relatively thick sections (10 μ) were used, so even the largest nuclei under investigation were entirely contained in the sections; all the slides were treated together and in the same baths to ensure a uniform Feulgen reaction throughout the whole experiment. Transmittances were measured in the wave-length region 5,200–5,400 A., on areas of the preparation varying between 0·27 μ^2 and 2·41 μ^2. The calculated mean optical density of the object multiplied by its surface gives the amount of deoxyribonucleic acid expressed in arbitrary units; no attempt was made to calculate absolute amounts, and the figures reported here have only relative values.

The results are shown on the accompanying histograms. The relative amounts of deoxyribonucleic acid are plotted logarithmically on the abscissæ, and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates.

As reference, the spermatozoa present in the general cavity and the mid-gut cells were measured. As expected, the mean deoxyribonucleic content of the (diploid) mid-gut cells (235 units) was found to be nearly twice the content of the (haploid) spermatozoa (114 units). The contents of the ovarian cells vary between very wide limits. However, the histogram shows clearly the existence of frequency maxima in successive ratios of 1, 2, 4, 8, 16, etc. The arrows on the graph indicate the mean value calculated for each frequency maximum.

The highest frequency maximum, located at 235, corresponds very closely to the theoretical diploid value. The cells belonging to this group are normal oogonia and normal oocytes at different periods of growth, irrespective of their dimensions. The next highest frequency maximum, located at 460, a value double that of the theoretical diploid content, corresponds to cells morphologically identical to the former ones, the density of the nucleus excepted, and the appearance of which is normal. The next maximum, at 915, corresponds to abnormal cells, which begin to degenerate as described previously, and the maximum at 1,835 to cells in which the Feulgen-positive material is collected in large homogeneous drops. At the extreme right of the histogram are cells which are expelling the deoxyribonucleic acid.

The existence of frequency maxima in the successive ratios of 1 and 2 in cells the destiny of which is to degenerate confirms the hypothesis that the origin of cell degeneration in the ovarian cells of *Artemia* is increasing polyploidy by successive reduplication. The first duplication leads to apparently normal cells. Whether these cells can develop further in a normal way is an open question; it may be suggested that the abortive developing eggs showing polycentry which are so common in *Artemia* may be such cells which have undergone maturation and fertilization. The second and third reduplications seem to be always lethal. The shape of the histogram suggests a fourth reduplication, but the expulsion of the deoxyribonucleic acid droplets occurs in many cases before this reduplication is completed.

On the left of the histogram, a frequency maximum at 120, very close to the theoretical haploid value, is clearly visible. All the cells belonging to this group are found in the ventral side of the ovary, in the region of multiplying oogonia. The existence of cells with such a deoxyribonucleic acid content is a puzzling fact. We are inclined to think that they are very young primary oocytes, just after the last oogonial division has taken place. They could be compared to the young spermatocytes of the rat recently studied by Lison and Pasteels[3]. In the rat, the last spermatogonial division follows another division immediately in such a way that no re-synthesis of deoxyribonucleic acid occurs between the two divisions. The content of the very young spermatocytes is therefore half that of the spermatogonia. The oogonia of *Artemia* probably behave similarly; but for the present we have not been able to present direct evidence favouring this view.

L. Lison

Laboratory of Histology,
Faculty of Medicine,
University, Brussels.
June 10.

N. Fautrez-Firlefyn

Institute of Anatomy,
University, Ghent.

[1] Fautrez-Firlefyn, N., *C.R. Soc. Biol.* (in the press).
[2] Lison, L., *Acta Anatomica* (in the press).
[3] Lison, L., and Pasteels, J., private communication.

Polymely in a Frog

The male frog (*Rana temporaria*) described here was found in a batch of frogs from Cornwall (January 1950) which had been killed before the supernumerary limb had been noticed. This supernumerary left fore limb was situated behind the normal fore limb and articulated with the sternum (Figs. 1 and 2). Bateson[1] records frogs with supernumerary limbs and O'Donoghue[2] gives a short summary of the types of supernumerary fore limbs found in frogs up to 1910. Including his own two specimens, O'Donoghue cites thirteen frogs with either one or two supernumerary fore limbs; of these only one (listed, but not described, in the catalogue of the Royal College of Surgeons, 1872) had the supernumerary limb

Fig. 1. X-ray showing articulation of supernumerary left fore limb with pectoral girdle

attached to the sternum. Wagner[3] describes a specimen with three extra but imperfect fore limbs (two right and one left) attached to "an extra basal piece overlying the sternum". Cotton[4] records a specimen with an extra right fore limb immovably articulated with an imperfect extra half pectoral girdle. Therefore, so far as I know, the present is the only specimen described with a "sternal glenoid cavity".

The supernumerary limb on this specimen was about four-fifths of the size of a normal limb, and complete as far as the wrist joint; but the metacarpals and phalanges were missing, perhaps as the result of injury. There was good movement in the "glenoid cavity" joint but very little in the elbow joint. In the region of the carpals there was a black sex pad about half the size of the pad on the normal limbs.

The muscles of the sternal region were slightly modified, as fibres from the pectoralis and coracoradialis passed to both the left normal limb and to the supernumerary limb. The other muscles of the limb were not examined in detail; but the general impression was of normal musculature (cf. O'Donoghue and Cotton).

The pectoral girdle was normal except that the anterior end of the mesosternum was bifid, and the posterior end twisted to the left (Figs. 1 and 2), and modified to form a cup-shaped articulating surface ("glenoid cavity") for the head of the humerus. The xiphisternum was apparently missing (probably incorporated into the "glenoid cavity" during development). The humerus and radio-ulna were typical although slightly smaller than those of normal limbs; also the carpal bones present seemed fairly normal.

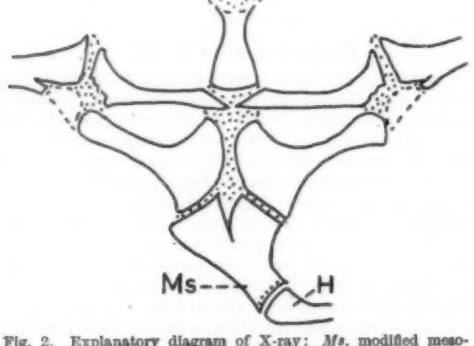


Fig. 2. Explanatory diagram of X-ray: *Ms*, modified mesosternum; *H*, supernumerary humerus

The blood supply to the limb consisted of an artery arising from the left subclavian just before it entered the normal limb. This artery entered the supernumerary limb a short distance from its proximal end, and after giving off two small branches to the tissue around the "glenoid cavity", it continued down the limb. The veins from the limb joined to form a large vein which entered the subclavian vein about halfway along its length.

The nerve supply to the supernumerary limb consisted of a small nerve (Fig. 3, *A*) arising from a secondary plexus formed by branches of the second and third spinal nerves; the other branches from this plexus supplied the skin and muscles of the body wall.

Fig. 3. Brachial plexus: *A*, nerve to supernumerary limb

The fact that polymely is more common[1] in hind limbs than in fore limbs of frogs suggests that the production of such limbs is due to injury and that the operculum affords protection to the fore limbs during a vital stage in development. Although the blood and nerve supply to the supernumerary limb in this specimen suggest that this limb had a common origin with the normal left fore limb, it is difficult to see how the articulation with the sternum was effected.

A. G. Hamilton

Biological Department,
St. Thomas's Hospital Medical School,
London, S.E.1.
Aug. 9.

[1] Bateson, W., "Materials for the Study of Variations" (1894).
[2] O'Donoghue, C. H., *Zool. Anz.*, **35**, 759 (1910).
[3] Wagner, G., *Biol. Bull.*, **25**, 313 (1913).
[4] Cotton, H. S., *Anat. Rec.*, **24**, 247 (1922).

Suckling Antidiuresis in Rabbits

Little direct evidence exists that the act of suckling stimulates the release of posterior pituitary hormone as is postulated in Petersen's[1] theory of the letdown of milk. Peeters *et al.*[2] reported a milking antidiuresis in cows which was simulated by intravenous injection of 4 mU. posterior pituitary extract. This dose had no effect on letdown in the cow. Turner and Cooper[3] described a swelling of the mammæ in lactating rabbits with intravenous injections of 1 mU. posterior pituitary extract. Experiments were undertaken to find if suckling in rabbits evokes an antidiuretic response which might be attributable to the neurohypophysis.

Nine crossbred rabbits were studied during thirteen lactations. Observations were made between the seventh and thirtieth day of lactation. Does separated overnight from their litters were given by stomach tube 50 c.c./kgm. body weight tepid water, followed 90 min. later by a second dose of 40 c.c./kgm. body weight. The bladder was emptied by manual

expression at 15-min. intervals and the urine volume measured. In most cases the urine flow rose to between 10 and 20 c.c./15 min. at the second collection and maintained this level in control experiments for an hour or more before decreasing. The normal course of water diuresis was not found to be significantly affected by gentle handling, presence of strangers, laboratory noise, confinement with the litter without nursing, or even coitus. In fifty-four experiments, suckling was allowed during the height of a water diuresis. In forty-eight cases the urine flow was diminished by 30–90 per cent. Maximum oliguria was observed most frequently half an hour after suckling, recovery of the urine flow occurring by ½–1 hr. During the antidiuresis, the chloride concentration of the urine samples, estimated by the Whitehorn method, increased by as much as four times the presuckling level. In five experiments the absolute urinary chloride excretion also increased. The magnitude of the responses bore no obvious relation to the amount of milk withdrawn, the duration of suckling or the size of the litter.

The antidiuretic responses following suckling were similar to those following intravenous injections of small doses of 'Pituitrin' (Parke Davis Co.). Assays in four animals indicated an effect equivalent to 0·5–1·0 mU. posterior pituitary extract.

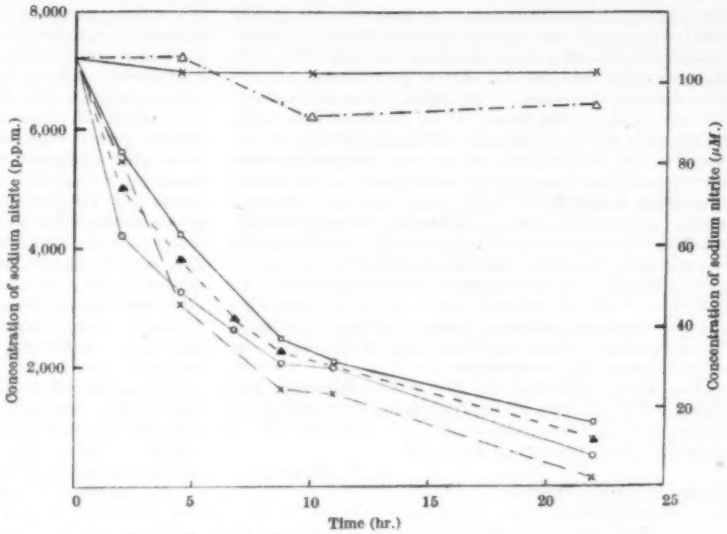
These experiments support the view that suckling in the rabbit stimulates the release of neurohypophysial hormone. The relation, if any, between suckling antidiuresis and letdown remains undetermined. Further experiments are in progress to elucidate the role of the neurohypophysis in both phenomena.

I wish to express my thanks to Dr. G. W. Harris for much practical help and advice during the course of this work.

B. A. Cross

Physiological Laboratory,
Cambridge.
June 30.

[1] Ely, F., and Petersen, W. E., *J. Dairy Sci.*, **24**, 211 (1941).
[2] Peeters, Coussens, Boukaert and Oyaert, *Arch. int. Pharmacodyn.*, **80**, 355 (1949), and private communication.
[3] Turner, C. W., and Cooper, W. D., *Endocrin.*, **29**, 320 (1941).



Elimination of sodium nitrite by *Achromobacter* sp. ×——×, heated bacterial suspension; △—·—△, control (no bacterial suspension); □——□, bacterial suspension; no donator added
×——×, ,, ,, + sodium lactate
▲——▲, ,, ,, + ,, succinate
○——○, ,, ,, + glucose

Preservation of Fish by the use of Nitrite Ice

In view of recently published accounts of work on the use of nitrites in the preservation of fish[1–3], the results of some experiments carried out here in 1941, which will be fully reported elsewhere, are of interest.

These experiments, which formed part of a wartime programme, were designed primarily to explore the possibility of improving the keeping quality of fish by the use of ice in which various preservatives, such as hydrogen peroxide, formaldehyde, sodium nitrite, etc., had been incorporated.

Briefly, it was shown that by using concentrations of 0·1 per cent and 0·15 per cent sodium nitrite in the ice, the period of 'freshness' of the fish, as judged organoleptically, could be prolonged for an extra three to four or seven to eight days respectively, as compared with controls in ordinary ice. The chemical data showed that the production of trimethylamine, the concentration of which was used as an objective index for quality, was correspondingly suppressed. Where ice containing 0·1 per cent sodium nitrite was continuously renewed to replace wastage through melting, the nitrite concentration in the flesh of the iced fish rose and reached 400 p.p.m. about the tenth day, after which it rapidly declined, reaching zero about the twenty-third day. With 0·15 per cent sodium nitrite in the ice, the decline from a peak value of 500 p.p.m. began after the fifteenth day, but some nitrite remained even after the twenty-third day. It seemed very probable that bacterial reduction was mainly responsible for the fall in nitrite concentration, and indeed it was comparatively easy to isolate in pure culture many strains of bacteria which were shown to reduce sodium nitrite. It was found, in agreement with the Canadian workers, that these reducers belonged mainly to the *Pseudomonas* group, although some *Achromobacter* strains were also involved.

Although *Pseudomonas* and *Achromobacter* strains reducing sodium nitrite had already been described[4–7], the reduction mechanism was—and still is—ill-defined. For this reason one of the micro-organisms, probably an *Achromobacter* species, which vigorously reduced sodium nitrite in fluid medium with foam formation, was isolated at the time of these experiments for a further study of the enzyme system involved. The work, however, had soon to be abandoned in the face of more urgent problems, and shortly afterwards the collection of stock cultures, including

the sodium nitrite reducers, was lost. So far it has not been possible to return to the problem; but the preliminary results then obtained showed that: (1) the organism at *p*H 7·0 actively reduced sodium nitrite to free nitrogen, only traces of ammonia being formed at the same time; as no attempt was made to set up a nitrogen balance, it was impossible to say whether all the sodium nitrite was reduced to free nitrogen or had been partly assimilated or converted into other nitrogenous compounds such as hydroxylamine, amino-acids, etc.; (2) the reduction, with well-washed cells, appeared to be practically unaffected by the addition of glucose, succinate and lactate as hydrogen donators; (3) the enzyme system appeared to be sensitive both to toluene and potassium cyanide; (4) the organism reduced sodium nitrate to nitrite, but at a much lower rate than that of the reduction of sodium nitrite to nitrogen.

The work described in this communication was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

J. M. Shewan

Torry Research Station,
Aberdeen.
May 31.

[1] Dyer, W. J., *J. Fish. Res. Bd. Can.*, **7**, 461 (1949).
[2] Castell, C. H., *J. Fish. Res. Bd. Can.*, **7**, 528 (1949).
[3] Dyer, W. J., and Castell, C. H., *J. Fish. Res. Bd. Can.*, **7**, 536 (1949).
[4] Russakova, G. S., and Butkevich V. S., *Mikrobiologiya*, **10**, 137, (1941).
[5] Christensen, H. R., *cf. Bakt. Abt.*, (2), **11**, 190 (1903).
[6] Yamagata, S., *Acta Phytochimica (Japan)*, **11**, 145 (1939).
[7] Meiklejohn, J., *Ann. App. Biol.*, **27**, 558 (1940).

Availability of the Magnesium of Grass to the Ruminant

In a previous communication under the above title[1], it was shown that the greater part of the magnesium of grass is liberated during the processes of ruminal and abomasal digestion. The ability of the animal to absorb this magnesium has been further studied.

It was unfortunately not found possible to carry out accurate determinations of magnesium balances, and experiments were confined to the determination of the percentage utilization of the dietary magnesium. In view of Nicolaysen's results[2], which indicate that the magnesium of faeces is unabsorbed food magnesium with a small amount derived from intestinal secretions, it was considered that, despite the limitations of the method, some information of value might be acquired.

At the time this work was commenced, the only suitable small laboratory animal available was the guinea pig. It has been shown that ruminal organisms play only a small part in the liberation of magnesium of plant materials[1], and it was assumed that results obtained using a non-ruminant herbivore such as the guinea pig would not differ widely from those obtained with the ruminant. This has since been shown to be the case by applying a lignin-ratio technique and using cattle.

Grass samples were collected during the dry season of 1948–49 (October–February) and during the wet season of 1949 (June–August). No attempt was made to separate species of grasses, and all samples were cut at random from pastures normally grazed by cattle, with the exception of one sample of wet-season grass which came from an area on which cattle had not been pastured. This sample, and the dry-season samples, consisted largely of spear grass (*Imperata cylindrica*). A list of the other principal grasses found at this Laboratory has been published elsewhere[3]. All the hay had been made from grass cut in August and September 1948.

A stock of grass sufficient for the whole experimental period was cut at one time and stored under conditions designed to keep it as fresh and moist as possible. Random samples were taken from this stock for the estimation of magnesium, calcium, phosphorus, lignin and crude fibre. At first an attempt was made to estimate lignin by a method based on the separation technique described by Bondi and Meyer[4]; but inconsistent results were obtained and the method of Ellis, Matrone and Maynard[5] was therefore used. In the latest series the method of Armitage, Ashworth and Ferguson[6] has been employed.

It was found that, in this series of experiments, 65–86 per cent of the magnesium of fresh grass is retained by the guinea pig and 63–74 per cent by cattle. Rather less (35–58 per cent) of the magnesium of hay is retained by the guinea pig.

The amount of magnesium retained is apparently not dependent upon the magnesium content, the calcium – phosphorus ratio or the crude fibre content of the food.

I am indebted to Mr. W. G. Beaton, director of veterinary services, Nigeria, for permission to publish this communication.

R. J. Garner

Veterinary Research Laboratory,
Vom, Northern Nigeria.
May 25.

[1] Garner, R. J., *Nature*, **164**, 458 (1949).
[2] Nicolaysen, R., *Skand. Arch. Physiol.*, **73**, 75 (1936).
[3] Garner, R. J., *J. Comp. Path.*, **60**, 108 (1950).
[4] Bondi, A., and Meyer, H., *Biochem. J.*, **43**, 248 (1948).
[5] Ellis, G. H., Matrone, G., and Maynard, L. A., *J. Anim. Sci.*, 5, 285 (1946).
[6] Armitage, E. R., Ashworth, R. de B., and Ferguson, W. S., *J. Soc. Chem. Indust.*, **27**, 241 (1948).

Effect of Temperature on the Consolidation of Soils

In civil engineering practice it is sometimes necessary to estimate the probable rate of settlement of structures founded on clay and other compressible soils. The settlement arises from a process in soil known as consolidation, in which the application of a load to the surface of the soil causes water to be expelled from its pores. *A priori*, it would be expected that the rate of consolidation of the soil would be a function of the kinematic viscosity of the water, and since the latter depends upon the temperature, it follows that the rate of consolidation should also be a function of temperature.

In order to check this hypothesis an experimental study has been made of the effect of temperature on the rate of consolidation of saturated samples of London clay. Samples of soil 3 in. in diameter and 1 in. thick restrained laterally were compressed between two porous disks, and the compression after various periods of time up to twenty-four hours was noted. The tests were made at a number of temperatures between 15° C. and 45° C. The results confirmed that, within the limits of experimental error, the coefficient of consolidation (a function of the rate of the process) was inversely proportional to the kinematic viscosity of water.

Since the temperature of the subsoil at depths normally encountered in civil engineering work is of the order of 10° C., it is thus necessary to make a correction for temperature when making estimates of settlement from the results of consolidation tests carried out on samples of soil at normal laboratory temperatures (say, 20° C.). Failure to make this correction can result in appreciable errors in the estimation of settlements; for example, if the laboratory tests are carried out at 20° C. and the average temperature at foundation-level is 10° C., the estimated settlement at any given time would be about 30 per cent too great. It is suggested that the neglect of this factor may be partly responsible for some of the considerable discrepancies noted in the past between calculated and measured settlements of structures founded on compressible soil.

The work described above was carried out at the Road Research Laboratory of the Department of Scientific and Industrial Research as part of the programme of the Road Research Board. This note is published by permission of the Director of Road Research.

W. A. Lewis

Road Research Laboratory,
Harmondsworth, Middlesex.
May 26.

Ultrasonic Soldering of Aluminium

For some years it has been known that it is possible to tin aluminium and its alloys by subjecting their surface to the action of intense ultrasonic vibration at the same time as molten solder is applied[1–3]; but the mechanism for this effect does not seem to have been studied. We have now established that the process is one of removing the oxide skin by cavitation erosion.

A specimen of aluminium was immersed in a bath of molten solder, to which were communicated vibrations at a frequency of 18 kc./s., set up by applying 50 W. to the driver coil of a small magnetostrictor. The exact amplitude of oscillation in the bath could not easily be determined, but was adequate to tin an aluminium surface immediately at atmospheric pressure. When, however, the experiment was repeated with an ambient pressure of 4 atmospheres, tinning was completely prevented. Since the increased pressure can have had only a negligible effect on any factor other than cavitation, this seems convincing evidence of the essential part played by the latter.

Aluminium is known to have a low resistance to cavitation erosion, even in water[4], so it is not surprising that collapsing voids in molten solder will be able to disrupt the surface, exposing the aluminium underneath for alloying with the metal which is impinging violently against it in the very action of cavitation. We can expect, moreover, that the usefulness of the ultrasonic technique for tinning different 'difficult' metals will be related to their susceptibility to cavitation erosion. In the limited studies that have so far been made, this has been found to be true.

We have found that ultrasonic cavitation must be expected to be more severe at lower frequencies[5], so we should expect that ultrasonic tinning would also be more effective in this region. Most experiments that have been reported have been done at relatively low frequencies, although it has been implied that vibration at 1,750 kc./s. can facilitate soldering[6]. We have used a 1,000-kc./s. crystal to which 3 kV. (root mean square) was applied, and have verified that it was not possible to tin aluminium in a pool of molten Wood's metal resting on it, although such tinning occurred quite readily in the low-frequency bath, where the ultrasonic intensity was appreciably lower.

Thanks are due to the directors of the Mullard Radio Valve Co., Ltd., for permission to publish this note, and to Dr. C. F. Bareford, manager of the Electronic Research Laboratory, for his help in the work described.

B. E. Noltingk
E. A. Neppiras

Mullard Radio Valve Co., Ltd.,
Electronic Research Laboratory,
Cross Oak Lane, Salfords,
Nr. Redhill, Surrey.
June 8.

[1] Fidesgesellschaft, Brit. Patent App., 15,773/39.
[2] *BIOS Rep.* 1844, Item No. 21 (H.M.S.O., 1946).
[3] Thomas, F. W., and Simon, E., *Electronics*, **21**, 90 (1948).
[4] Donaldson, J. W., *Metal Industry*, **60**, 383 (1942).
[5] Noltingk, B. E., and Neppiras, E. A., *Phys. Soc. Proc.*, B, **63**, 674 (1950).
[6] Sivian, L. J., U.S. Patent 2,426,650.

The Discovery of Magnesium

In a recent little book entitled "The Story of Magnesium", issued by the American Society of Metals in 1949, the author, W. H. Gross, states (p. 17): "The discovery of magnesium is generally attributed to Sir Humphrey [*sic*] Davy in 1808. He did not actually obtain magnesium in metallic form, but merely established the fact that magnesium oxide was the oxide of a new metal. Magnesium was first isolated in 1828 by the French scientist Bussy. . . ."

Such a statement is entirely misleading, as a study of the paper read before the Royal Society by Davy on June 30, 1808, and published in the *Phil. Trans.*, **98**, 333 (1808), renders abundantly clear.

After describing his now well-known method of obtaining an amalgam using a mercury cathode, Davy states that he heated it in a glass tube from which all air had been expelled: "I found immediately that the mercury rose pure by distillation from the amalgam and it was very easy to separate a part of it; but to obtain a complete decomposition was very difficult. For this nearly a red heat was required, and at a red heat the bases of the earths instantly acted upon the glass and became oxygenated. . . . The metal from magnesia seemed to act upon the glass even before the whole of the quicksilver was distilled from it. In an experiment in which I stopped the process before the mercury was entirely driven off it appeared as a solid having the same whiteness and lustre as the other metals of the earths. It . . . quickly changed in air, becoming covered with a white crust and falling into a fine powder which proved to be magnesia" ("Alembic Club Reprints", No. 6; 1894).

Although Davy may not have succeeded in obtaining magnesium entirely free from mercury, there can be no doubt that in some of his experiments he obtained an almost pure product. Who would expect high chemical purity at the first attempt? Davy did far more than merely establish the fact that magnesia was the oxide of a new metal.

There was, of course, no 'e' in Davy's Christian name.

J. Newton Friend

134 Church Road,
Moseley,
Birmingham 13.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 9

CHEMICAL SOCIETY, SOUTHAMPTON SECTION (joint meeting with the Mid-Southern Counties Section of the Royal Institute of Chemistry and the Portsmouth and District Chemical Society, at the Municipal College, Portsmouth), at 7 p.m.—Prof. H. J. Emeléus, F.R.S.: "The New Elements".

Tuesday, October 10

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Human Biology as an Academic Topic".*

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. E. A. G. Shaw: "The Rectangular Acoustic Wave-Guide—a Study of Plane and Higher Order Mode Waves and their use in Acoustic Impedance Measurements of Porous Surfaces at Normal and Oblique Incidence".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Sir Henry Dale, O.M., F.R.S.: "Scientific Method in Medical Research".*

(Further Lectures on October 12, 17, 19, 24, 26, 31, November 2, 7, 9, 21, 23, 28, 30, December 5, 7, 12, 14, 19 and 21.)

UNIVERSITY OF LONDON (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S.W.1), at 5.30 p.m.—Prof. D. Keilin, F.R.S.: "Nature and Properties of certain Metalloprotein Enzymes".*

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Sir Harry Lindsay: "The Scope and Pattern of Geography".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Virus Research: Present and Future" (Speakers: Dr. C. H. Andrewes, F.R.S., Mr. F. C. Bawden, F.R.S., Mr. N. W. Pirie, F.R.S.).

ROYAL SOCIETY OF MEDICINE, PSYCHIATRY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. E. O. Lewis: "Intelligence in relation to Modern Social Trends" (Presidential Address).

Wednesday, October 11

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 3 p.m.—Symposium on "Air Disinfection and Sterilisation".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. J. Heeley: "A Metallurgist in the Chemical Industry" (Presidential Address).

Thursday, October 12

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. Z. Young, F.R.S.: "Man as a Subject for Scientific Study".*

UNIVERSITY OF LONDON (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Dr. B. Katz: "The Nature of the Nerve Impulse".*

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. E. A. C. L. E. Schelpe: "The Vegetation of Mount Kenya" (illustrated by a Kodachrome cine film).

WOOL EDUCATION SOCIETY (in the British Council Film Theatre, 6 Hanover Street, London, W.1), at 6.30 p.m.—Prof. J. B. Speakman: "Careers in Wool" (Inaugural Lecture).

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 13

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Joel Stebbins: "The Electrical Photometry of Stars and Nebulæ" (George Darwin Lecture).

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with the Royal Institute of Chemistry and University College Chemical Society, at University College, Swansea), at 5.30 p.m.—Prof. F. Challenger: "Some Aspects of the Chemistry of Sulphur Compounds occurring in Nature".

CHEMICAL SOCIETY, NORTH WALES SECTION (joint meeting with the University College of North Wales Chemical Society, in the Department of Chemistry, University College of North Wales, Bangor), at 5.45 p.m.—Prof. T. S. Wheeler: "Studies in the Synthesis of Flavones".

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helens), at 6 p.m.—Prof. W. E. S. Turner, F.R.S.: "The Chemical Durability of Glass".

Saturday, October 14

PHYSICAL SOCIETY, COLOUR GROUP (at University College, Gower Street, London, W.C.1), at 11 a.m. and 2.30 p.m.—Symposium on "The Technique of Subjective Judgments".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT SECRETARY TO THE BRITISH PHARMACOPOEIA COMMISSION—The Chairman, British Pharmacopoeia Commission, 44 Hallam Street, London, W.1 (October 14).

DEMONSTRATOR IN PHYSIOLOGY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2 (October 16).

RESEARCH ASSISTANT (graduate) in the field of vacuum spectroscopy (a good honours degree in physics and some experience in high vacuum work are required)—Prof. R. W. Ditchburn, The University, Reading (October 16).

CHEMIST to carry out investigations on the problem of spray retention on foliage—The Secretary, Research Station, Long Ashton, Bristol (October 21).

ASSISTANT LECTURERS (3) IN THE DEPARTMENT OF PHYSIOLOGY, for posts in Physiology, Biochemistry and Biophysics—The Registrar, University College, Cathays Park, Cardiff (October 28).

LECTURER IN MORAL AND POLITICAL PHILOSOPHY in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, October 31).

METEOROLOGICAL OFFICERS (6) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 31).

SENIOR LECTURER IN CHEMICAL ENGINEERING at the New South Wales University of Technology—The Agent General for New South Wales, 56 Strand, London, W.C.2 (October 31).

TECHNICAL ASSISTANT (male) to the head of establishment at the Air Ministry Survey Production Centre at present located at Teddington, Middlesex—The Secretary, Civil Service Commission, Scientific Branch, London, W.1, quoting No. 3310 (November 9).

LECTURER or ASSISTANT LECTURER in the Fluid Motion Laboratory—The Registrar, The University, Manchester 13 (November 11).

CHAIR OF MATHEMATICS in the University College, Dundee—The Secretary, The University, St. Andrews (November 15).

LECTURER IN THE DEPARTMENT OF GEOGRAPHY at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Nottingham.

ASSISTANT LECTURER (Grade III—Non-Medical) or LECTURER (Grade II—Medical) IN PHYSIOLOGY—The Secretary, The University, Birmingham 3.

ASSISTANT to undertake analytical biochemistry work in the Research Unit for Juvenile Rheumatism—The Director, Special Unit for Juvenile Rheumatism, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP, tenable in the Department of Mechanical Engineering—The Registrar, The University, Nottingham.

CHEMIST with the Colonial Insecticides Research Unit now operating in Tanganyika—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

DEMONSTRATOR (graduate with experience in Chemical Analysis) IN THE ENVIRONMENTAL ARCHÆOLOGY DEPARTMENT—The Secretary, Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.

DEMONSTRATOR IN PHARMACY—The Registrar, The University, Nottingham.

DIRECTOR OF THE ROYAL HORTICULTURAL SOCIETY'S GARDENS, Wisley, Surrey—The Secretary, The Royal Horticultural Society, Vincent Square, London, S.W.1, marking envelope "Confidential".

ENTOMOLOGIST for the Medical Department, Gold Coast—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27215/159.

GEOPHYSICIST and a GEOLOGIST for service in the Geological Survey of the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, marking envelope "Geophysicist" or "Deputy Government Geologist", as appropriate.

LECTURER IN CHEMISTRY—The Principal, Royal Technical College, Salford 5.

LECTURERS or DEMONSTRATORS (part-time) IN BOTANY or ZOOLOGY in the Intermediate and Final B.Sc. Courses—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN MECHANICAL ENGINEERING, particularly Mechanics, for the Department of Civil and Mechanical Engineering—The Secretary, Royal Technical College, Glasgow.

PRINCIPAL and LECTURER IN AGRICULTURE AND BIOLOGY at the College of Agriculture in Mauritius—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27059/257.

RESEARCH FELLOWS IN (a) CLIMATOLOGY (open especially to graduates in botany and agronomy), and (b) PHYSIOLOGY (open to graduates in geology, soils and geography)—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada.

SENIOR ASSISTANT (Scientific) IN THE DEPARTMENT OF NUTRITION, to be engaged mainly in physico-chemical methods of estimating vitamins and other factors—The Secretary, National Institute for Research in Dairying, Shinfield, Berks.

SENIOR HOSPITAL PHYSICIST at the Radiotherapy Centre, Queen Elizabeth Hospital—The Secretary, United Birmingham Hospitals, The Queen Elizabeth Hospital, Birmingham 15.

SENIOR LECTURER (Senior Assistant) IN METALLURGY—The Principal, Sir John Cass College, Jewry Street, Aldgate, London, E.C.3.

TECHNICAL OFFICER (Mapping) required by the East Africa High Commission for the Desert Locust Survey Headquarters at Nairobi—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/26642/3E.